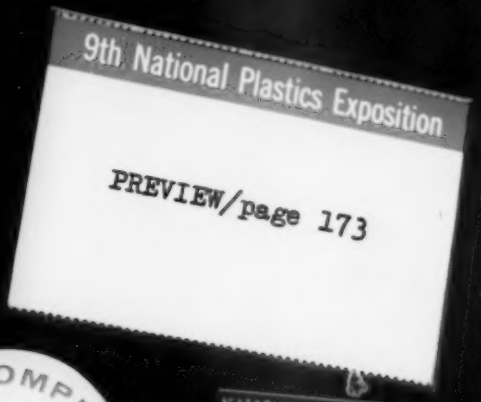
Materials
in Design Engineering



MAY, 1961

VALUE ANALYSIS FACT SHEET

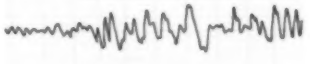
Formbrite Drawn Brass Parts

How to open finishing room bottlenecks and cut polishing costs up to 50%—produce stronger, more scratch-resistant parts—and get additional savings —with Formbrite, superfine-grain drawing brass.

Very often in the production of drawn brass parts which are to be plated or lacquered, finishing costs are greater than those of all preceding operations —or even the cost of the metal. Under any circumstances, they are a high percentage of total costs.

Furthermore, parts go through the pressroom a lot faster than they can through the finishing room, creating bottlenecks in production.

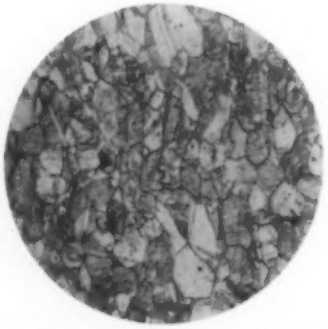
ENLARGED SURFACE TRACES at the right prove that you can lick both cost and time problems with Formbrite®, Anaconda superfine-grain drawing brass. Savings in polishing costs reported by users run from 40 to 50%. These are net savings, as Formbrite costs no more than ordinary drawing brass.



Enlarged surface trace of standard drawing brass (grain size, .045 mm) after 40% elongation. This kind of roughness causes "orange peel" effect in the working of standard drawing brass. Smoothing such mountains down to the valleys takes considerable cutting.

Enlarged surface trace of Formbrite drawing brass (grain size, .005 mm) after 40% elongation. Surface smoothness after deformation is the test of a drawing brass's polishing characteristics. It is relatively easy to level these little hills on the surface of Formbrite. In many cases, users find they eliminate cutting operations altogether, need only a simple color buff.

STRONGER, MORE SCRATCH RESISTANT. Formbrite is stronger, harder, springier than the usual drawing brasses in the same standard tempers, yet retains remarkable ductility for forming and drawing, and takes sharp, clean-cut ornamental die impressions. The harder surface means fewer rejects from scratching and marring during handling. In some instances, the superior strength and hardness of Formbrite make possible the use of a thinner gage metal, with an additional saving in material cost.



This is the microstructure, shown 75x, of the standard drawing brass used above.

This uniform superfine-grain structure of Formbrite, shown 75x, is produced by special procedures for rolling or drawing and annealing developed by Anaconda American Brass Company.

SIZES AND TEMPERS. Brass manufactured by the Formbrite method, with its special characteristic of superfine-grain structure, is supplied in standard Formbrite temper, half-hard, three-quarter-hard, hard, and extra-hard tempers, and can be rolled in heavy coils to .004" in thickness by 24" wide, weighing 100 pounds per inch of width. The table below gives physical data and terminology for Formbrite tempers.

ALLOYS. In addition to 70-30 brass, the following Anaconda alloys also are produced by the Formbrite method: Yellow Brass-59, Gilding Brass-4, Commercial Bronze-14, Red Brass-24, and Low Brass-32.

TECHNICAL ASSISTANCE. For help in selecting the alloy and temper to handle your particular job—for a copy of Publication B-39 with more details about Formbrite—see your Anaconda representative. Or write: Anaconda American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 6145

TERMINOLOGY FOR FORMBRITE TEMPERS

TENSILE STRENGTH LB. SQ. IN.		ROCKWELL B HARDNESS		DESIGNATION TO BE USED
MIN.	MAX.	MIN.	MAX.	
49,000	59,000	40	65	Yellow Brass—Formbrite
57,000	67,000	60	77	Half-hard Yellow Brass—Formbrite
64,000	74,000	72	82	Three-quarter-hard Yellow Brass—Formbrite
71,000	81,000	79	86	Hard Yellow Brass—Formbrite
83,000	92,000	85	91	Extra-hard Yellow Brass—Formbrite

FORMBRITE

Superfine-grain drawing brass

a product of

ANACONDA®

Anaconda American Brass Company

MAY, 1961 | VOL. 53, NO. 5

Materials in Design Engineering®

FORMERLY MATERIALS & METHODS

APPLICATION OF METALS, NONMETALLICS, FORMS, FINISHES

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Switching from aluminum to Zamak sliced casting costs in half on this Whitehead ball bearing bobbin holder. And with seven zinc die castings accounting for all the major working parts, overall costs dropped a neat 12%.

This high volume item is found on spinning frames in cotton mills—it's designed to take twenty to thirty years of rugged, day-in day-out service. Yet by using Zamak instead of aluminum, the wall thickness of certain parts was reduced from .065" to .050". This resulted in a decrease in material cost with no loss in strength. Whitehead Die Casting plans to bring their costs down still further by going to wall thicknesses of .032"—with the toughness of the parts still unaffected as far as their performance goes.

Besides the healthy cost savings directly related to the reduced wall sections, Zamak also provides Whitehead with a familiar success story—"faster and more economical production . . . longer die life . . . less rejects." Zamak gives you more for less — — —

WHITEHEAD BALL BEARING BOBBIN HOLDER

AWARD OF MERIT

THE NEW JERSEY ZINC COMPANY'S "DIE CASTING OF THE YEAR" COMPETITION

CASTING COSTS CUT 50%

are YOU getting your METAL'S WORTH?

HORSE HEAD® SPECIAL ZINC AND HORSE HEAD ZAMAK ARE PRODUCED BY

THE NEW JERSEY ZINC COMPANY

160 FRONT STREET • NEW YORK 38, N. Y.

DEVELOPERS OF THE ONLY STANDARD ZINC DIE CASTING ALLOYS IN USE TODAY

HORSE HEAD PRODUCTS

For more information, turn to Reader Service card, circle No. 430

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NEXT MONTH

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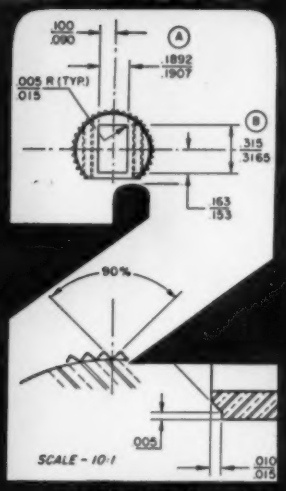
Acetal Moldings vs Zinc Die Castings . . . Based on a field survey of engineers who have used both, this report tells how these materials compare in performance and cost.

Also: Try Wood for Chemical Processing Equipment . . . Functional Styling with Wire . . . Temperature Coefficients for Low Expansion Materials . . . Boron Silicides . . . and many new developments in engineering materials and processes.

This Month's Cover *by Harry & Marion Zelenko.*

BLUEPRINT FOR



Transforming these lines and numbers into the functional reality of a sintered brass brush holder for small electric actuator motors took teamwork. A design engineer conceived it, and a metal powder fabricator brought it to fruition—at a 65% cost saving over the previous method of manufacture.

It might not have been this way. Despite a design engineer's careful planning, his blueprint could be a neatly drawn recipe for an ulcer – when looked at by a metal powder fabricator aware of the advantages and limitations of his art. Often, a fabricator has little choice but to turn out a part he knows could be made infinitely better—could be made with increased reliability, more wearability, less machining and lower costs.

Working together, the metal powder fabricator and design engineer make economical mass production of critical parts a reality. And we also mean "critical" in the sense that a whole is no better than the quality of its most prosaic part. For more information about the design, application and advantages of nonferrous metal powder parts, write today to The New Jersey Zinc Company for your copy of "Designing For Pressed Brass and Nickel Silver Parts."

Part by KWIKSET POWDERED METAL PRODUCTS Division of American Hardware Corporation

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How Nickel gets music out of solid rock

Deep in the Caverns of Luray in Virginia is one of the world's musical marvels—the famed "Stalacpipe" organ—a unique instrument that gets rare tonal beauty from age-old stalactites.

To get music out of solid rock, the stalactites have threaded metal rods bolted through them—close to small, wire-wound magnets. When an electronically-controlled hammer strikes a stalactite, the combination of rod and magnet becomes a tone generator whose impulses pass out through an amplifier.

Imagine the dampness of the Caverns . . . the rust-producing environment . . . and what could soon happen to these musical rods bolted through the rock. Here is where a metal has to really prove itself.

Nickel means trouble-free performance. To prevent excessive rust and resulting expansion that could easily crack or snap off the stalactites, a special electrical steel—a steel with Nickel in it—was chosen. This high nickel alloy steel—47-50% Nickel—stands up to the eternal dampness of this underground concert hall . . . and provides the exact combination of magnetic properties needed for low power requirements and full high fidelity.

Don't overlook Nickel even if you're not thinking of building an underground organ anytime soon. Alone or with other elements Nickel improves hundreds of alloys . . . makes possible almost any combination of properties for fabricating or service demands.

Whatever your metal problem—high or low temperatures, corrosion, stress, or an unusual combination of factors—consider the advantages of Nickel. For more information, just write us.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

Big tone from little Nickel alloy rods. Pen shows the size of Allegheny Ludlum Steel Corporation's AL-4750 nickel alloy special steel rods bolted through ancient stalactites. The rods vibrate with the rock after being struck by rubber-tipped hammers.

INCO NICKEL
NICKEL MAKES ALLOYS PERFORM BETTER LONGER

Centrifugal castings made of 100% pure tungsten have been produced. Key to the process is melting the metal in a crucible-skull vacuum arc furnace. The crucible is water cooled. The tungsten centrifugal castings are hollow rings measuring up to 10 in. i.d. and weighing up to 220 lb.

Source: Oregon Metallurgical Corp., Albany, Ore.

A new epoxy resin for 310 F (formerly Class F) uses is said to be the most flexible epoxy system now available. The one-part epoxy has a Shore hardness of D18, compared to D55 for most semiflexible epoxy resins. Because it exerts little, if any, pressure on embedded parts during cure the resin can be used as a void-free impregnant or encapsulant for parts with sensitive core materials.

Source: Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.

Gallium arsenide for electronic devices is now available in single and polycrystalline forms. The compound is supplied undoped, or doped with zinc, cadmium, manganese, tellurium or tin.

Source: Alloys Unlimited Chemicals, Inc., 42-73 Hunter St., Long Island City 1, N. Y.

A new tungsten steel for tools and dies is said to offer up to four times the service life of high carbon, high chromium steels. According to the developer, the steel through-hardens in sections up to 6 in. when oil quenched from 1450 F. Intricate parts up to 2 in. in dia can be air hardened from 1550 F, whereas air hardening carbon-chromium types require heating to 1800 F.

Source: Carpenter Steel Co., 101 W. Bern St., Reading, Pa.

Look for ultra high strength composite materials to come out of present research. Preliminary work is being done on aluminum-sapphire composites. The final objective is to achieve a strength-to-weight ratio of 600,000 in. at 2000 F.

Source: W. H. Sutton, General Electric Co., Missile and Space Vehicle Dept., 3198 Chestnut St., Philadelphia 4.

A new flexible polyethylene, a copolymer of ethylene and ethyl acrylate, has properties similar to those of flexible vinyls. But it has no plasticizer, precluding the possibility of migration or volatilization problems, and eliminating the need for compounding. Three grades are available: 1) an extrusion and blow molding grade; 2) a film grade containing anti-block additives; and 3) an injection molding grade. Reports indicate the material may be quite similar to the elastomeric polyethylene discussed in more detail on p 14 of this issue.

Source: Dow Chemical Co., Midland, Mich.

Nickel-plated molybdenum sheets and strips for use in semiconductor devices are now commercially available. According to the producer, the nickel can be applied to one or both sides of the molybdenum sheet; if plating is done on one side only, the unplated side is electropolished to remove surface impurities.

Source: Chromium Corp. of America, P. O. Box 1229, Waterbury 20, Conn.

New precoated couplings for underground pipelines are said to have excellent corrosion resistance. Reason: the couplings have a three-layer coating consisting

B.F.Goodrich

New way to protect your metal product... a temporary but tough coat of Geon

Panels for this building were coated and fabricated by Elwin G. Smith Company, Pittsburgh, using "Strip-Gard" strippable vinyl coating made with Geon vinyl by Stoner-Mudge Company, Pittsburgh, a Division of American-Marietta Company. It can be applied by all standard methods including brush, reverse roll, spray, dip, flow and conventional roll coating. B.F.Goodrich Chemical Company supplies the Geon vinyl.

Here's a temporary coating that goes on metal fast, strips off easily. Meanwhile, it gives polished, embossed or coated metals protection during fabrication, storage and shipping. It's an organosol based on Geon vinyl.

Since the coating stretches well and is very flexible, you can corrugate, emboss, roll-form or draw metals coated with it without affecting the coating. In some cases, it eliminates the need for lubrication. Wear on expensive plated or polished dies is significantly reduced. And there's no need for final cleanup after fabrication or assembly.

Because it's made of Geon, the coating protects metals from the effects of oil, grease and from discoloration or etching of corrosive chemicals. It provides excellent resistance to scratching or abrasion. The manufacturer says it's not designed to protect against weathering, but it will—tests show no staining or embrittlement outdoors for periods up to six months. And the desirable stripping qualities are not impaired.

Here's another way that Geon vinyl is opening new markets, making possible new or improved products. Want more information? Write Department NN-3, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. In Canada: Kitchener, Ontario.

B.F.Goodrich Chemical

a division of The B.F.Goodrich Company

Geon VINYLS

For more information, turn to Reader Service card, circle No. 421

of a specially formulated phenolic resin, a coal tar-epoxy resin combination, and a hot coal tar enamel. Heat from the coal tar enamel bonds the three coatings together, providing a permanent bond to the coupling.
Source: Dresser Mfg. Div., Dresser Industries, Inc., Bradford, Pa.

Stronger, more flexible graphite cloth has been obtained by modifying the complex processing techniques formerly used to convert organic fibers such as rayon into essentially pure graphite fibers. Tests show the improved cloth has a breaking strength of 25 lb, compared to 8 lb for previous material. Flexibility of the improved cloth is double that of the old material, according to the developer. Graphite cloth was first announced two years ago (M/DE, May '59, p 149).
Source: National Carbon Co., Div. of Union Carbide Corp., 270 Park Ave., New York 17.

A new high strength steel has ASME approval (Case No. 1297) for pressure vessel applications. Three big advantages of the steel are: 1) it sells for $47 a ton less than the only other "superstrength-rated" ASME approved pressure vessel steel; 2) it keeps its strength at both low and high temperatures; and 3) it has excellent weldability under constrained conditions.
Source: Great Lakes Steel Div., National Steel Corp., Detroit 20.

Graphite coated with titanium nitride withstands 3600 F for 60 sec in a Mach 2 airstream, recent research shows. Uncoated graphite is severely damaged after 20 sec and destroyed after 60 sec in the hot airstream. The coated graphite, still in the developmental stage, is expected to be used in missiles and rockets. The coating is applied by gas plating.
Source: Technical Note D-722, National Aeronautics and Space Administration, Washington 25, D. C.

New free-cutting brass hexagon rods with a rounded corner design are said to provide lower metal loss, better product appearance and longer screw machine life than conventional sharp-cornered rods. The new hexagon rods are used primarily for making brass bolts, nuts, automotive fittings, and other parts where the hex serves as a wrenching shape.
Source: Titan Metal Mfg. Co., Div. of Cerro Corp., Bellefonte, Pa.

A new 'slippery' rubber for seals and packings retains elasticity and other desirable properties of natural and synthetic rubbers. Seals made of the rubber are said to perform satisfactorily for long periods of time on rotary and reciprocating shafts without lubrication. The rubber is made by a process which uses ultraviolet irradiation, grafting, hydrolysis and fluorination. It is still under development.
Source: Quantum Inc., Lufbery Ave., Wallingford, Conn.

Ductile beryllium metal has been produced by using a specialized floating zone refining technique, details of which have not been revealed. Tests show that zone-refined single crystals of beryllium are about 50 times more ductile than currently available high purity grades of the metal. The ductile metal is still in the developmental stage.
Source: Franklin Inst., 221 N. 21st St., Philadelphia.

Turn to page 9 for more "What's New in Materials"

HOB TWO
FOR THE PRICE
OF ONE
By switching to a lead-treated steel, Thor Power Tool Company cut the cost of these idler gears in half. Aristoloy 4620 (leaded*) provided high strength with excellent wear and shock resistance qualities. On gear cutting operations, machinability jumped from 35% to 66% (of B 1112). And there was a marked improvement in surface finish.
If you would like to know more about the production economies of lead-treated steels possible on hobbing, broaching, milling, and particularly automatic machining operations, write today for LEADED STEELS CATALOG. Or call your nearest Copperweld representative.
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4021 Mahoning Ave., Warren, Ohio • EXPORT: Copperweld Steel International Co., 225 Broadway, New York 7, N. Y.

For more information, turn to Reader Service card, circle No. 403

Cheaper Titanium Castings

seem assured as a result of a new casting process using steel molds with an expected life of 100 parts

■ Mass production of titanium impellers, valve bodies, fittings, and pump housings and sleeves may become economically feasible with a new casting process that increases mold life about eight times—from 12 parts to 100 parts.

Called Impel Casting, the process consists of melting a double-melted titanium electrode under vacuum and pushing it into a steel die cavity. The change from conventionally used graphite to steel, together with the much longer mold life, results in a considerable slash in mold amortization cost per part.

The process was developed and is being used by Titanium Metals Corp. of America, 233 Broadway, New York 7, N. Y. Present equipment limitations restrict castings to a maximum weight of 12 lb and maximum size of 5 to 10 by 24 in.

***First part** produced by a new titanium casting process is a 9-in. dia impeller weighing 12 lb.*

Sound castings

Because TMCA is gearing its production to chemical process applications, it is casting unalloyed titanium to obtain maximum corrosion resistance. Depending on the grade chosen, yield strength ranges between 25,000 and 100,000 psi.

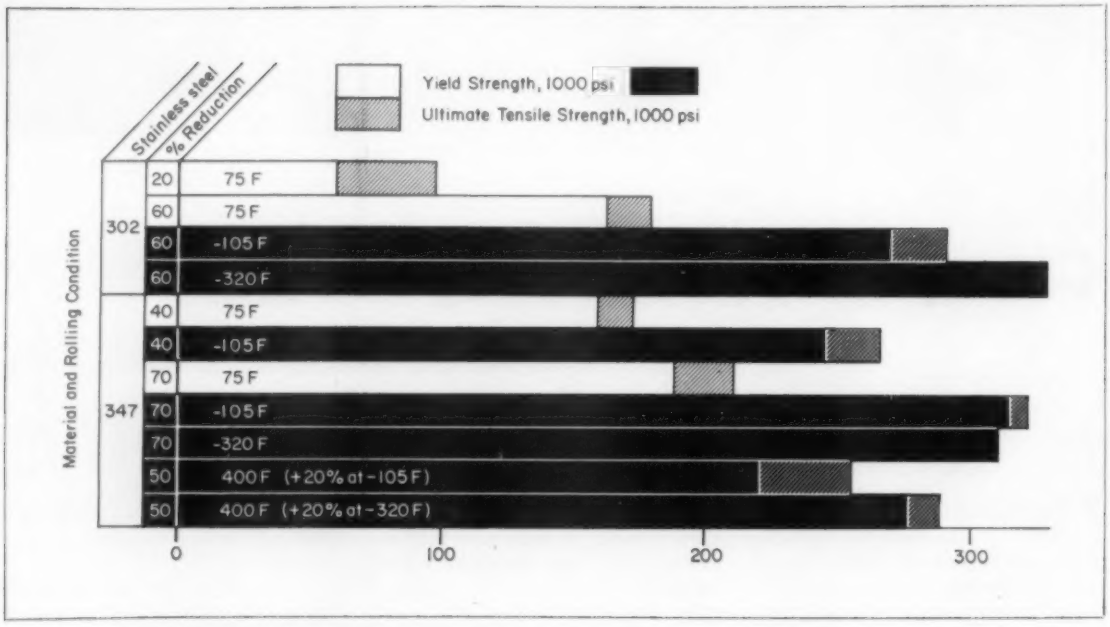
Because of the fluidity of titanium, the process can turn out accurate and intricate parts. Porosity has been found only in sections thicker than ½ in. No surface porosity has been encountered. According to TMCA, dies can be designed to shift porosity to areas where it is not harmful.

A cost comparison

The 12-lb, 9-in. dia impeller shown in the photograph was made by the new process. Total cost of nine such impellers, including mold cost, was lower than that of nine similar impellers fabricated by welding.

On large production runs, TMCA says, the dies themselves might be cast to further reduce piece cost.

For more information, circle No. 634



***Lower rolling temperatures,** as well as greater reductions, markedly increase the tensile and yield strengths of types 302 and 347 stainless steel. (These results are for specimens stress relieved 24 hr at 800 F).*

Zerolling Boosts Strength

■ As the bar chart shows, rolling at temperatures as low as −105 F, or lower, can greatly increase the strength of certain stainless sheet. Such improvement is obtained without any sacrifice in ductility or impact strength; in fact these properties are better after zerolling than after room temperature rolling.

In addition, zerolled sheet retains its strength for longer times at elevated temperatures than ordinary sheet.

Not all stainless steels respond to zerolling. Essentially, the process transforms the structure of the steel from austenite to martensite. Thus, the most responsive steels are those such as types 301, 302 and 304 which have a metastable austenite matrix. Zerolling has a minimum effect upon steels with a more stable austenite matrix, such as types 309 and 310. The difference in response is shown clearly in Fig 1.

Since zerolling produces a martensitic structure, zerolled stainless steels are ferromagnetic.

Zerolled sheet has been produced in small quantities by Universal-Cyclops Steel Co.

Effect of temperature

Reasons for the zerolling effect are not really known, but we do know that the M_s point of austenite in stainless steel (i.e., the temperature at which austenite transforms to martensitic) is low. Thus, temperatures much below room temperature are needed to produce the transformation during rolling.

Zerolling temperatures can be as low as −320 F. The optimum rolling temperature, however, is probably −105 F. As Fig 2 shows, strength increases as rolling temperature decreases, but the maximum effect occurs when rolling temperature is lowered from 70 F to −105 F. The percentage increase in mechanical properties between −105 F and −320 F is not great enough to justify rolling at the lower temperature.

The bar chart shows that different rolling sequences may result in similar properties. Reducing type 347 stainless steel 50% at 400 F and 20% at −105 F produced approximately the same yield strength as a 40% reduction at −105 F. Although not shown on the bar chart, it has also been found that combined warm-cold rolling results in higher strength values than a cold-warm sequence.

Strength with toughness

As the bar charts indicate, yield strengths exceeding 300,000 psi can be achieved by zerolling. Because yield and tensile strengths are nearly identical after some zerolling sequences, it is important to handle the sheet carefully during fabrication.

Ordinarily, austenitic stainless

Plastic deformation at subzero temperatures can increase the yield and tensile strengths of some austenitic stainless steels as much as 70%. Zerolled sheets are now commercially available.

by D. W. McDowell, Jr. and J. R. Mihalisin, *International Nickel Co.*

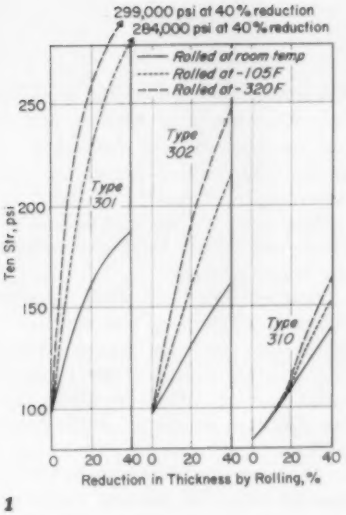
# of Stainless Sheet

steels lose strength rapidly above the 800 to 1000 F range. The comparative curves in Fig 3 show that zerolled sheet retains its strength at such temperatures to a greater degree than steels cold rolled at room temperature.

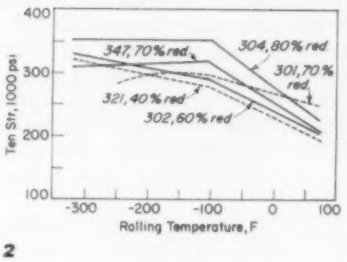
The increase in ductility obtained from zerolling is indicated in Fig 4. Using type 302 as an example and a tensile strength level of 170,000 psi as a reference point, the curves indicate that ductility increases as rolling temperature is decreased. Room temperature rolling results in 7% elongation; rolling at −320 F provides 25% elongation.

No data are given here to support the earlier statement that zerolling improves impact strength, but experience has shown that this is true for austenitic stainless steels for a given percentage of cold reduction.

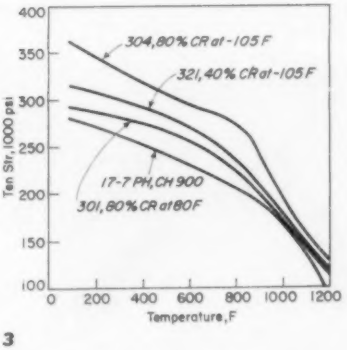
For more information, circle No. 635



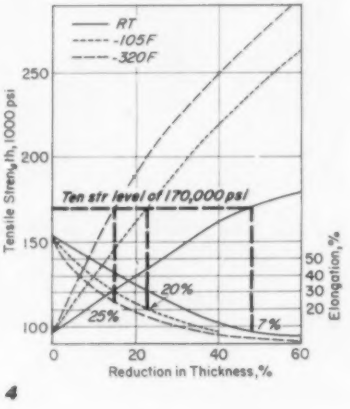
1 *Rolling austenitic stainless steels at subzero temperatures greatly increases tensile strength. Type 310, which has a relatively stable austenite matrix, does not show the improvement that is evident for types 301 and 302. The latter steels have an unstable austenitic matrix.*



2 *Greatest increase over room temperature properties is developed by rolling at −105 F. Reductions at −320 F result in either no significant increase or a disproportionately small increase.*



3 *Zerolling improves elevated temperature properties. Comparison of types 301 and 304 clearly shows that the initial higher strength of zerolled type 304 is maintained at all temperatures.*



4 *Tensile strength and elongation of type 302 stainless are compared after zerolling and rolling at room temperature. At a tensile strength level of 170,000 psi, greatest elongation (25%) is found in the specimen rolled at −320 F.*

Epoxy Pellets

Speed Production of Electronic Components

by Vincent Sussman,
Vice President,
Epoxy Products, Inc.,
Div. of Joseph Waldman & Sons

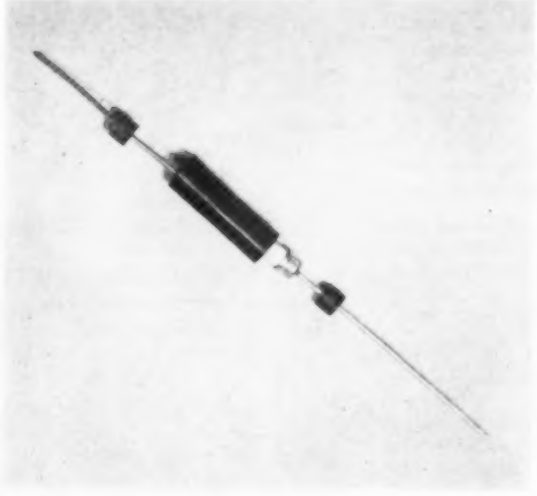
■ A novel mass production technique for encapsulating, impregnating, sealing and bonding electronic components has been developed using epoxy pellets along with molded forms and epoxy headers. The pellet system, called "E-Pak," requires minimum tooling and fixturing and uses no pressure that might break fine wires. It is particularly suited to miniaturized assemblies.

Epoxies have excellent electrical, thermal and chemical properties, and are well suited to the new production methods because they are thermosetting and will not remelt. They bond well to glass, metal and ceramics, and their properties can be varied by the addition of fillers, flexibilizers and other modifiers.

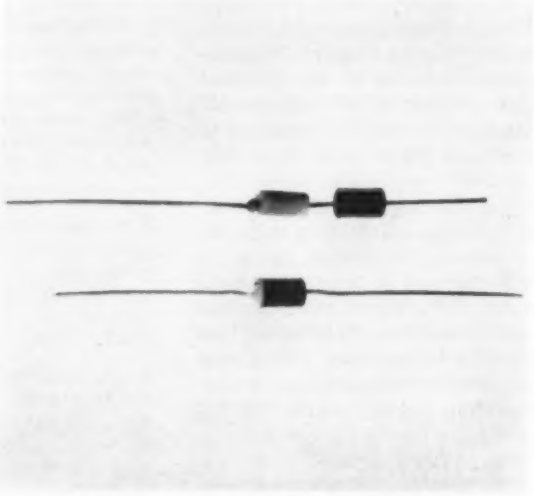
The epoxy pellets are available in a variety of premolded sizes, shapes and volumes to exactly fill and encapsulate each component or package. A component to be encapsulated is inserted into a fully cured shell and the preformed epoxy pellet is positioned around the component. Similarly, a number of small components can be mounted on an epoxy header and then encapsulated in a case containing a pellet. When passed through an oven, the pellet melts and fuses to the epoxy case to form a homogeneous, rugged solid.

This technique can be modified in many ways. Here are seven different applications.

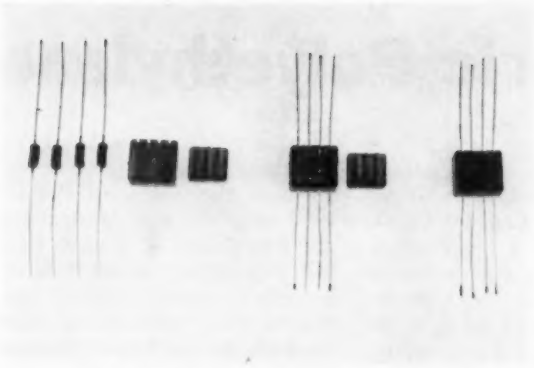
For more information, circle No. 636



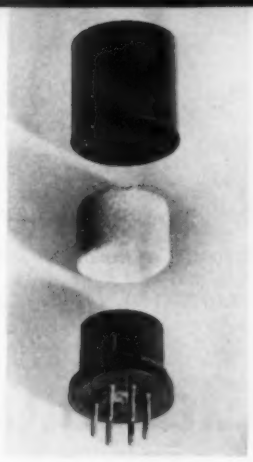
***Carbon film resistor** is protected by molded epoxy sleeves and pellets. In assembly, the axial lead resistor is inserted into the sleeve and a pellet is threaded onto each lead as shown here. When heated and cured, the resistor is sealed in an all epoxy enclosure with an air space trapped around the carbon film.*



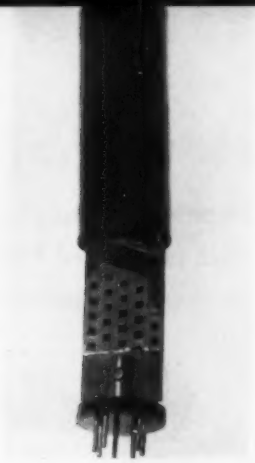
***A silicon diode** to be packaged in epoxy is first coated with an inert material, such as silicone resin. The diode is then threaded into an epoxy pellet which has been inserted into the epoxy case. The diode rests on the shoulder of a pellet having a larger i.d. at one end than the other. Heating fuses the pellet into a solid. Hundreds of diodes can be processed simultaneously.*



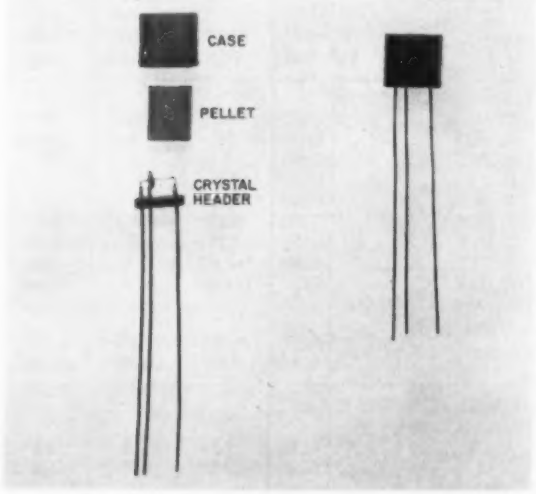
Groups of glass diodes *packaged in single epoxy blocks are useful for many applications. The diodes are aligned in a rectangular plastic case with their leads resting in slots (left and center). An epoxy pellet with ridges matching the grooves between the diodes is positioned on top of the case and heated. It flows around the diodes and bonds with the case to form a homogeneous cured mass (at right).*



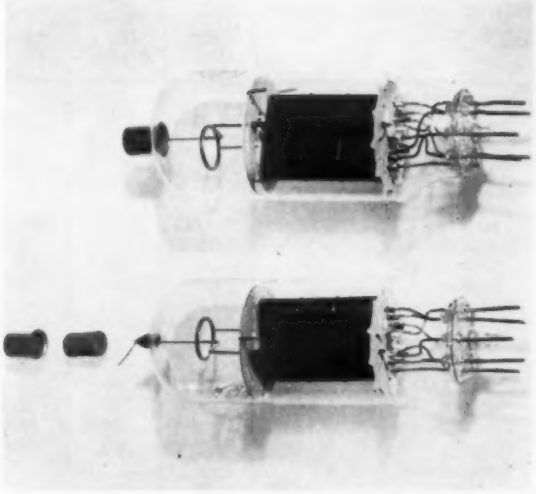
Miniature pulse transformers *have been sealed by the E-Pak system using a molded case, a pellet, and a header carrying the transformer leads. Heating and curing create a rugged, sealed unit highly resistant to shock and other environmental effects.*



Miniature circuits *often require packaging to protect them from vibration, shock and other destructive conditions. However, the fine wire leads often short when they are packed closely together. Dense packaging leaves little room for the encapsulant. The new package consists of an epoxy container and header with a printed circuit board. Components are mounted on the board and inserted into the case containing liquid epoxy. When cured, the solid epoxy has great mechanical stability.*



Transistors *can be encased in epoxy in spite of their need for good heat dissipation. Loading the pellet with powdered aluminum provides the required thermal conductivity. The transistor crystal is coated with silicone resin and mounted in the epoxy header. The pellet is placed in the case and the assembly is held in a fixture and heated. The method eliminates solder flux or weld splash contamination.*



Metal caps *used on many radio tubes can be fastened more securely with epoxy than with conventional glueing methods. An epoxy pellet is threaded on the lead wire and the cap is installed over it (bottom). Flame heaters cure the epoxy and bond it securely to the tube envelope, lead and cap (top).*

In parts such as these bellows you may have trouble with plasticized PVC because of low temperature stiffness or plasticizer migration. If so, try a . . .

New Elastomeric Polyethylene

■ A new ethylene copolymer material, elastomeric in nature, may give flexible PVC (polyvinyl chloride) some strong competition, particularly in parts requiring low temperature flexibility, such as auto and refrigerator gaskets, sheet formed parts for automobiles, and certain types of flexible tubing and inflatable toys.

The material, developed by Union Carbide Plastics Co., Div. of Union Carbide Corp., 270 Park Ave., New York 17, and designated DPDB-6169, can be injection or blow molded, extruded or calendered. According to Union Carbide, it offers a combination of flexibility over a wide temperature range, nonmigratory ingredients, toughness, good stress-crack resistance, and ease of processing. It is available commercially in truckload quantities at a price of 32.5¢ per lb (1.1¢ per cu in.). For comparison, a plasticized PVC might cost as low as 22.4¢ per lb (1.1¢ per cu in.).

Although its composition has not been disclosed, the material's low temperature characteristics are reminiscent of a more rigid low temperature polyethylene copolymer announced by Union Carbide in 1959, primarily intended for such uses as outdoor garbage cans (see M/DE, July '59, p 137). Chemical nature of that material was also undisclosed, but some observers reported it to be a copolymer of ethylene and an acrylate-type monomer.

TABLE 1—TYPICAL PROPERTIES: NEW COPOLYMER VS POLYETHYLENE, PVC[a]

Material →		DPDB 6169	Low Density Polyethylene[b]	Flexible PVC[c]
PHYSICAL PROPERTIES	ASTM			
Specific Gravity	.....	0.931	0.920	1.35
Melt Index, gm/10 min	D1238	6	1.5	—
Vicat Softening Temp, F	D1525	147	194	144
Specific Heat, Btu/lb/°F	.....	0.55	0.53	0.4
Coef of Lin Ther Exp, 10^{-5} per °F	D696	8.5-10	8.9-10	3.9-14.1
Coef of Friction				
Static	[d]	0.75	0.47	1.25
Kinetic	[d]	0.75	0.47	1.10
Water Absorption (24 hr), %	D570	0.04	0.03	0.11
MECHANICAL PROPERTIES				
Hardness, durometer				
Shore A	D676	86	—	90
Shore D	D676	27	45	30
Tensile Strength, psi	D412	1350	1800	2200
Elongation, %	D412	650	600	250
Compression Set, % recovery				
After 9 Days at 73 F	D395	56	50	20
After 22 Hr at 158 F	D395	18	30	25
Brittle Temperature, F				
50% OK	D746	>−157	−95	−15
80% OK	D746	−148	−80	−15
Flex Crack Resistance, 10^6 cycles to failure				
At 77 F	[e]	>2	0.040	>2
At 32 F	[e]	>2	>0.010	0.135

Material →		DPDB 6169	Low Density Polyethylene[b]	Flexible PVC[c]
Torsional Stiffness, 10^3 psi				
At −68 F	D1043	155	180	400
At −13 F	D1043	23	70	200
At 32 F	D1043	8	35	45
At 77 F	D1043	4.5	18	4.5
At 140 F	D1043	0.58	4	0.60
At 158 F	D1043	0.35	3	0.45
At 176 F	D1043	0.20	2	0.35
At 194 F	D1043	Too soft	1.4	0.25
At 212 F	D1043	Too soft	1.0	Too soft
Environmental Stress Crack Resistance, hr				
F_0	D1693	>500	1	>500
F_{50}	D1693	>500	>24	>500
ELECTRICAL PROPERTIES				
Dielectric Constant				
At 1 Mc	D150	2.7	2.3	5.3
At 50 Mc	D150	2.6	2.3	6.5
Power Factor				
At 1 Mc	D150	0.009	0.0003	0.1
At 50 Mc	D150	0.03	0.0004	0.1
Dielectric Strength (short-time), v/mil	D149	550	550	300-400
Volume Resistivity (73 F), megohm-cm	D257	2.4×10^9	$>1 \times 10^{11}$	1×10^8

[a]All specimens compression molded. [b]Bakelite DND-2450. [c]Bakelite VFD-9990.
[d]Special UCP test method consisting of dragging weighted test specimen across strip of same material. [e]Ross rubber test apparatus.

for Low Temperature Flexibility

Pros and cons in brief

From the data published, here's how the new material appears to stack up in comparison with typical plasticized PVC's:

1. Substantially improved low temperature flexibility, e.g., at -68 F the new material has a torsional stiffness of only 155,000 psi compared with 400,000 psi for a Shore A90 durometer PVC.

2. Contains no plasticizer, thus eliminating the possibility of lacquer-lifting, odor, or other problems caused by plasticizer volatilization, e.g., auto windshield fogging from PVC on dashboard.

3. More elastomeric in behavior than those PVC compounds containing nonvolatile, non-extractive types of polymeric plasticizers.

4. Easier to mold than PVC because of better thermal stability during processing.

On the other hand, the material is not as strong as PVC, appears to have somewhat lower heat resistance, and does not have PVC's inherent noninflammability.

Properties compared

Table 1 compares physical, mechanical and electrical properties of the new copolymer with those of a Shore A90 durometer PVC. Properties of a conventional low density polyethylene are also given. At room temperature the new material has a torsional stiffness comparable to that of the PVC, and about one-fourth that of the low density polyethylene.

Excellent low temperature flexibility is shown by 1) the low modulus at -68 F, 2) exceptional flex crack resistance at 32 F, and 3) the low brittleness temperature.

Electrical insulating characteristics appear to be superior to those of the 90 durometer PVC, falling between those of the PVC and the low density polyethylene.

Generally, parts fabricated with the new material have a dull matte or "leather-like" surface texture. Thus the material can be used as an overlay over high density polyethylene where the glossy finish characteristic of that material is undesirable. A high gloss surface can be obtained on the new material by using plated molds or plated rollers.

Weatherability of the material is similar to that of low density polyethylene. For outdoor use, the material should be filled with a finely-ground carbon black.

Table 2 shows resistance of the new material to various chemical reagents. Unfortunately, sufficient comparable data for plasticized PVC are not available. The data indicate that the new material does not have as good chemical resistance as does conventional polyethylene.

The material has not as yet been submitted for examination by the Food and Drug Administration; thus it cannot be recommended for use where FDA approval is required.

TABLE 2—CHEMICAL PROPERTIES

Material →	DPDB 6169	Low Density Polyethylene
CHEMICAL RESISTANCE, (D543), % wt gain		
Acetic Acid, 5%	1.1[a]	0.1
Acetone	10.4	—
Carbon Tetrachloride	Excessive[a]	39
Citric Acid, 50%	0.6[a]	0.2
Ethyl Alcohol, 95%	4.2	—
Ethylene Dichloride	79.1	—
Gasoline	54[a]	16
Heptane	101	—
Kerosene	39[a]	9.6
Lemon Oil (USP)	66[a]	15.5
Liquid Detergent "Lux"	1.4[a]	0.2
Methyl Ethyl Ketone	10.4[a]	2.2
Motor Oil (20-20W)	2.1	0.5
Nitric Acid, 95%	9.4[a]	0.2
Oxygen (wet gas)	1080	470
Sodium Chloride, 10%	0.2	—
Sodium Hydroxide, 10%	0.19	—
Sulfuric Acid, 3%	0.27	—
Tetrachloroethylene	Excessive[a]	42
Toluene	246	15.9
Turpentine	64[a]	11.5
Water, Distilled	0.1	—
PERMEABILITY, gm x in. /24 hr x 100 sq in.		
Acetic Acid, 50%	3.5	0.2
Acetone	50	9.0
Ethyl Acetate	110	25
Ethyl Alcohol, 95%	1.9	0.3
Heptane	810	250
Oxygen (wet gas)	—	—
Water, Distilled	0.8	0.1

[a]Specimen consisted of slightly different material, but data should be in proper order of magnitude.

Versatile in processing

DPDB-6169 has a somewhat lower melting range than low density polyethylene, but a similarly wide latitude in processing conditions. In injection and blow molding, it exhibits mold shrinkage equivalent to that of low density polyethylene.

The material can be extruded to form contours, sheet or film with ease. Extrusion conditions again are quite similar to those used for low density polyethylene. Information on calendering is limited as yet.

For more information, circle No. 637

Industrial rubber

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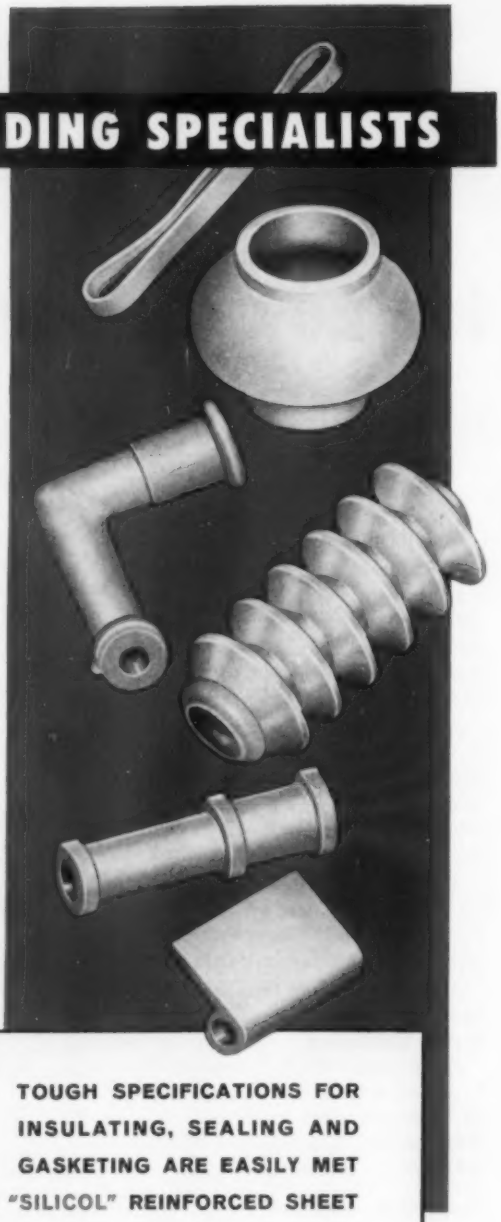

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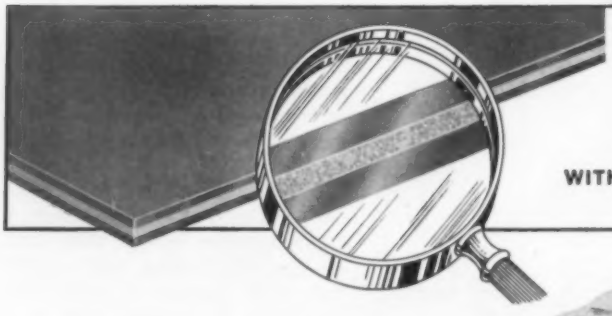
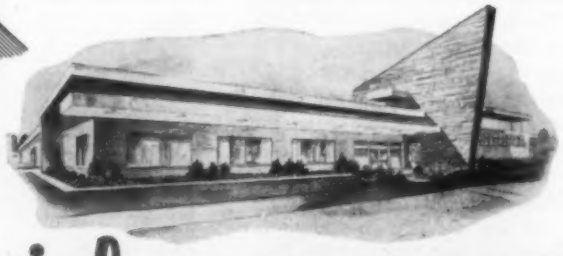


TOUGH SPECIFICATIONS FOR INSULATING, SEALING AND GASKETING ARE EASILY MET WITH "SILICOL" REINFORCED SHEET



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Center elastomeric layer of printed circuit board shown in photo cuts vibration transmissibility by one-half to two-thirds.

Circuit Laminate Damps Vibration

■ A new printed circuit laminate (Dyna-damp) with high damping power has been developed by Lord Mfg. Co., Erie, Pa. The high damping power of the laminate derives from an inner elastomer layer which dissipates vibratory energy by converting it into shear strains. It is claimed to be the first successful integrally damped printed circuit material and is expected to be instrumental in raising the reliability of high density electronic equipment in aerospace applications.

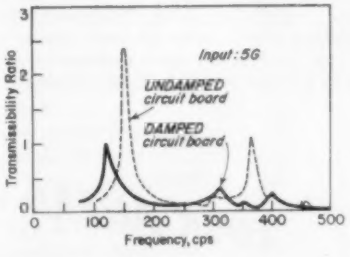
Laminate is epoxy-glass

As shown in photo, the heart of the damping board consists of a 0.02-in. thick layer of a silicone-type elastomer, chosen for its desirable combination of damping properties and resistance to expected environments. Both sides of the layer are bonded with an epoxy-fiberglass laminate (NEMA-G-11) which provides the desired electrical properties. The outer side of one or both epoxy-glass laminates is clad with copper. Total thickness of the fiberglass and copper layer is 0.032 in.

Construction of the laminate is similar to that of a damping board announced by Lord about a year ago. The earlier material is somewhat thicker than the printed circuit laminate and, of course, is not clad with copper. It is used as a vibration-damping mounting base for mechanical and electrical assemblies in aerospace applications.

Damping problem critical

The new laminate resulted from the need for a material that would resist the complex dynamic disturbances caused by high-performance jet aircraft and missiles. These vehicles produce higher G loads and higher vibrational frequencies and amplitudes than were encountered just a few years ago. For example, the top disturbing frequency in jet specifications use to be 55 cps; today 500 cps is considered nominal and excitation can even range as high as 5000 cps in missiles.



Vibration *transmissibility of damped and undamped printed circuit boards.*

These environments are tough on lightly damped printed circuit boards containing fragile components. Normally, either of two things can happen during vibration. First, the board may respond at its resonant frequency and oscillate so much that it strikes adjacent structures. The resulting shock can cause damage or shorting. Second, the energy transmitted through the board may exceed the G levels which components or the attaching material can withstand. This also can cause failure of vital components.

The new laminate minimizes these problems because it cuts down resonant structural response, thereby controlling amplitude and G loads. Tests show that under resonant conditions the laminate's transmissibility is reduced anywhere from 50 to 66% below that of an undamped board (see drawing). This excellent performance is primarily due to the special properties of the elastomeric medium which are retained over a temperature range of −65 to 250 F.

For more information, circle No. 638

the LEAD newsletter

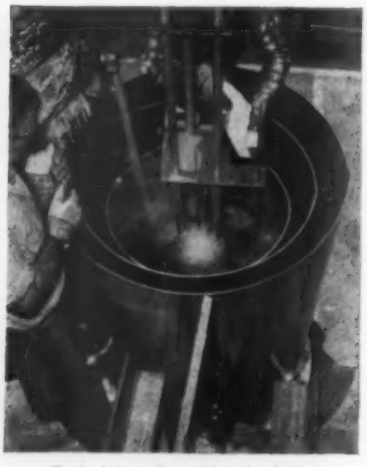
Vol. 3 No. 1

The use of lead to save weight is increasingly demonstrated by imaginative designers and engineers in many fields. They have often achieved the lowest total weight in their designs by taking advantage of lead's density. At 11.34 g or more per cc, depending on whether cast, rolled, or extruded, lead's density is the highest among the common, low-cost, commercial materials.

Lightweight Reactor Shielding

The effectiveness of lead in saving space when used for protective shielding against gamma- and X-radiation is known to everyone. Not recognized by many is the fact that a shielding of lead, when properly designed, is also usually lighter than other shielding materials. Increased thicknesses required for efficient shielding by other materials disproportionately increase the bulk of the shield.

The space/weight savings possible with lead are especially important, often critical, in reactors used to power ships and other forms of transportation, portable power plants, laboratory reactors, and the shielding of shipping containers.

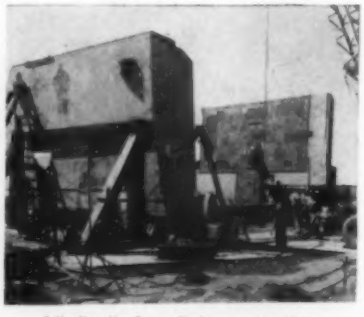


Technicians installing lead shot shielding in laboratory reactor.

Lead in shot form has the added advantage of handling ease when used in reactor design. Poured into the space allowed for shielding, it packs into every crevice, molds itself to wall contours without vibration, and may be drained off or replaced almost as readily as water.

Recommended for further reading on the subject is the booklet "Materials for Portable Nuclear Reactors," available on request from Lead Industries Association.

Smaller Counterweights Do a Bigger Job



Missile silo doors during construction at Vandenberg Air Force Base.

Because of its density, lead is widely used for making counterweights of many kinds. They range from the common small weights for balancing auto wheels to the huge weights, requiring altogether 10,000 tons of lead, used to balance the elevators and steel and concrete doors of the Titan missile launching system.

Lead weights obviously can be smaller than those made of materials of a lower density. Interestingly, weights required to do a given job can frequently be lighter when made of lead. Because lead weights are more compact, they can be concentrated at much greater distances from the fulcrum, where they have a greater counterbalance force.

In lead's favor is the ease with which it can be fabricated, by casting, extrusion, or rolling, to fit irregular spaces, or to form unusual shapes effecting maximum effectiveness at lowest weight. Where the use of heat casting is not desirable, the advantages of lead may still be realized through the use of lead wool, lead shot, or molded lead-impregnated plastic.

In Munitions Lead Unrivalled

A time-honored use of lead is the manufacture of ammunition. Here, too, the major factor that dictates its choice is density. It permits attainment of the high velocity required for maximum striking power and accuracy. The smaller surfaces required for a given weight reduce air resistance.

Lead Saves Space and Weight In Noise Barriers

In noise barriers such as partitions, the weight and limpness of lead produce savings in space and weight. Because of lead's high density, heavier partitions can be built in smaller spaces, increasing usable floor space. This combination of density and limpness means that partitions incorporating lead may be lighter in total weight yet be equal or better in sound-deadening effectiveness than partitions of other materials. The superiority of lead is technically detailed in "Improved Sound Barriers Employing Lead," available on request.

Through continuous research by L.I.A., lead and its many compounds are keeping abreast of changing technology. For technical information or assistance on new products or problems where lead's unusual capabilities may be of value, simply write: Office of Technical Information, Lead Industries Association, 292 Madison Ave., New York 17, N.Y.

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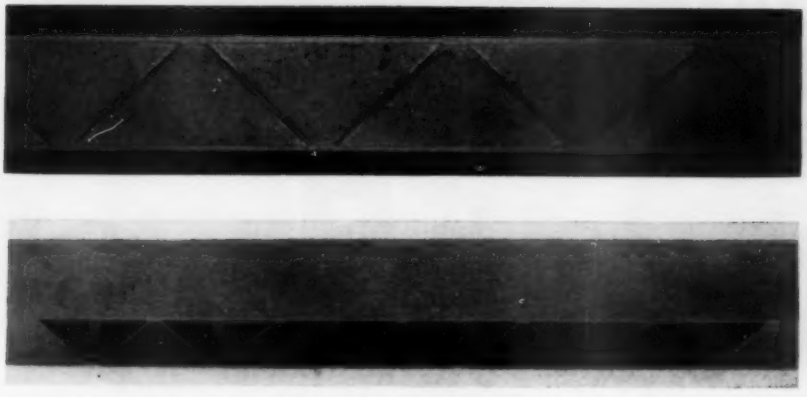
For more information, turn to Reader Service card, circle No. 343



***Sound welds** are evident in titanium sandwich at top, shown with iron insert wedges used to support core during rolling. At bottom is sandwich panel after wedges have been chemically leached out.*

Metal Honeycomb Costs Cut

by new process in which corrugated cores and cover sheets are simultaneously rolled and welded together.

■ A new process called roll welding simultaneously hot rolls and pressure welds the plates of corrugated metal cores to the cover sheets.

Simplicity of roll welding compared to conventional honeycomb techniques, which include critical brazing operations, is claimed to lower production costs approximately 50%.

To date roll-welded sandwich panels have been made from 2014 aluminum, 13V-11Cr-3Al beta titanium alloy, unalloyed A55 titanium, steel, molybdenum, beryllium and Inconel. Size of finished panels is limited only by rolling mill capacity; panels up to ¼ × 36 × 72 in. have been produced.

Roll welded panels are still being evaluated by Douglas Aircraft Co. which sponsored the development program at Battelle Memorial Institute. Commercial production has not yet begun but licenses are now available from Douglas.

How process works

To form the corrugated core, an accordion-pleated sheet of metal is woven over and under V-shaped inserts of a chemically soluble, deformation resistant metal such as copper or iron. A rectangular metal frame is placed around the core and sandwich face sheets are added. The assembly is held in place by two additional cover sheets welded to the frame. The package is then hot rolled in a direction parallel to the corrugations to weld the core to the covers and reduce package thickness up to 60%.

After rolling, the retaining frame is sawed or sheared off and the metal covers are peeled away. With the support wedges still in place the panel can be formed as if it were a solid metal sheet of equal thickness; the core does not buckle.

The support wedges are removed by acid leaching. Although leaching may require several days for large panels, it is a relatively

(continued on p 203)

MORE WHAT'S NEW IN MATERIALS

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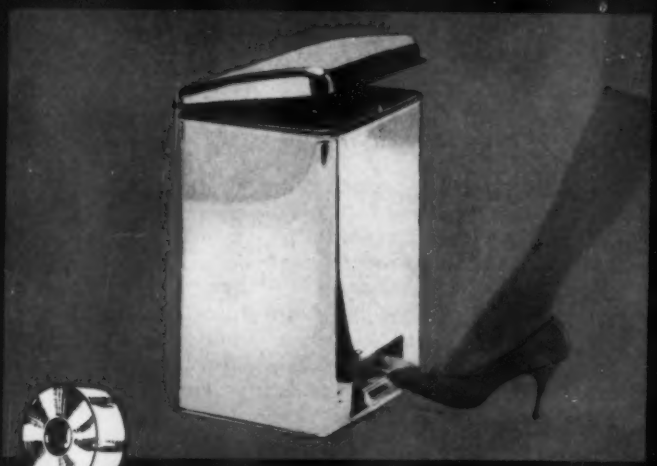
NICKELOID IS EVERYWHERE

IN MOST ANY ROOM

IN THE GAME ROOM



IN THE KITCHEN

These eye-catching products use functionally a basic Nickeloid Metal. The finish of Chromium, Nickel, Brass or Copper is electroplated to a base metal, usually Steel (but often Zinc, Brass or Copper).

Mostly, Nickeloid Metals are supplied in continuous coils in widths up to 24" for modern, low cost fabrication. They're also available in sheets and strips. Optional: bright or satin finishes, plating one or both sides, a galaxy of stunning patterns and crimps.

Quality plating produces metals so durable they can be fabricated, even quite severely drawn or bent. Rejects minimized. For severe stamping, we offer Mar-Not protective coating that is easily peeled off after its job is done.

These handsome articles of daily use are striking indeed! Not a little of this is achieved by the functional use of bright plated Nickeloid Metals in Chrome, Brass or Copper finishes. But look again! These pictures carry a deeper, even more dramatic story . . . the story of a *new concept* of manufacture. Not always do artisans work with raw steel sheet. Not always is the final finish applied by the extra step of painting or plating. With Nickeloid Metals this finish is built-in, and it's done by a company which has dedicated itself to electroplating of sheets and coils for industry for over 60 years! The use of Nickeloid Metals as a pre-finished raw material proves the theorem that a straight line is the shortest distance between two points. Write for free Introductory Kit that unfolds the entire story and provides you with metal samples. Or, phone a Nickeloid sales office in one of the principal cities.

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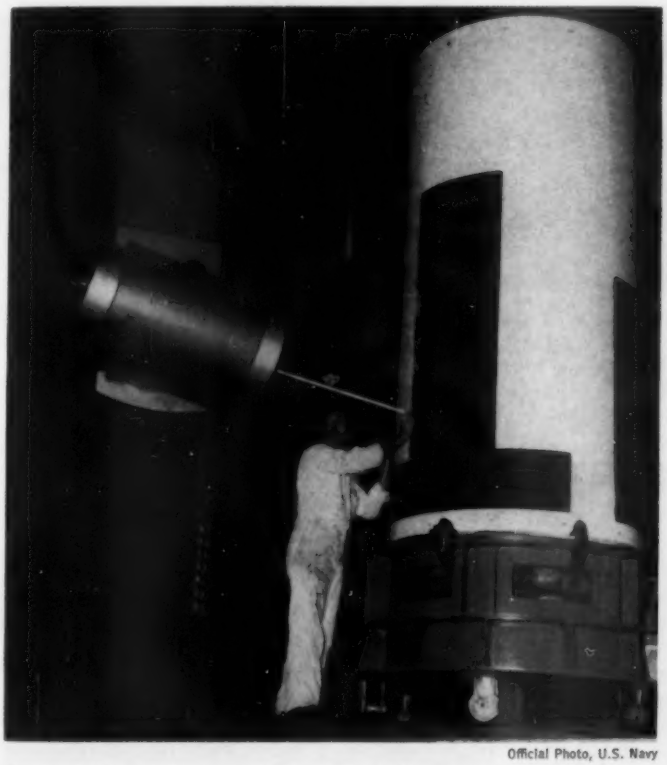
Standards, Research Urged for Filament Winding

Filament winding has achieved the status of a practical process and materials system, yet only a fraction of its potential is now being realized. The time has come to make a large scale effort to consolidate and standardize, and to develop reliable tests and quality control procedures.

This was one of the major conclusions to come out of a symposium on filament winding held a few weeks ago in Pasadena, Calif. An overflow crowd of 550 engineers and scientists attended this first national symposium sponsored by the Society of Aerospace Material & Process Engineers.

P.M. Goodwin, Bureau of Naval Weapons, said a comprehensive research effort is needed to exploit "this still young field for the outstanding potential it holds in terms of advanced materials."



Official Photo, U.S. Navy

***Ten million electron volt linear accelerator** being positioned to x-ray the solid propellant in a Polaris missile first stage. The accelerator, said to be the first of its kind and probably the most powerful in the world, is used by the U. S. Naval Ammunition Depot, Concord, Calif. to detect tiny, but critical flaws in the solid fuel of Polaris, Minuteman and Skybolt missiles. Designed and built for the Navy by Varian Associates, Palo Alto, Calif., the accelerator can detect imperfections through 78 in. of fuel or 15 in. of steel in a few minutes. Large-diameter rocket engines can be inspected in seconds.*

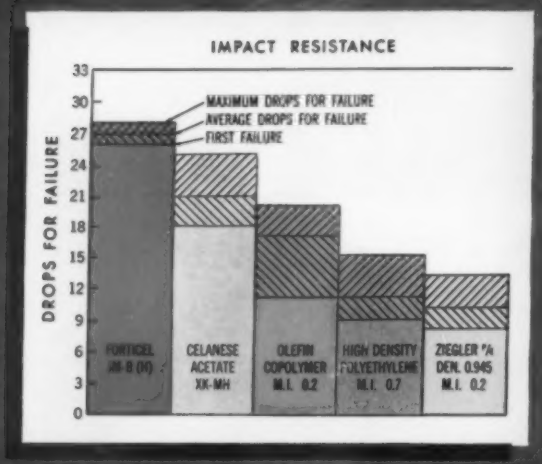
New developments revealed

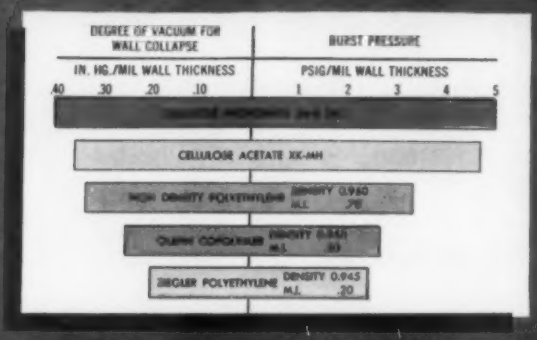
The program consisted of 30 papers by leading authorities in the field and covered the state of the art, developments in resins and filaments, manufacturing techniques, and testing and quality control. Some highlights of the meeting:

- A research program to develop methods for forming optimum fibers of such materials as boron, beryllia, alumina and zirconia that would extend the usefulness of filament wound structures to 2000 F was described by G. P. Peterson, Materials Central, Wright Air Development Div., USAF.
- C.E. Juran, Grand Central Rocket Co., suggested a method for filament winding directly on solid propellant rocket fuel grains. Such a procedure would avoid the problem of differential shrinkage between the case and the propellant.
- Use of preimpregnated tapes for filament wound structures was discussed by J.A. Anderson and F.T. Brewen, Zenith Plastics Co. They said that enough parts have now

For more information, circle No. 370

CELANESE POLYMER COMPANY




DEGREE OF VACUUM FOR WALL COLLAPSE
IN. HG./MIL WALL THICKNESS
.40 .30 .20 .10
BURST PRESSURE
PSIG/MIL WALL THICKNESS
1 2 3 4 5
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For more information, circle No. 498

been produced with prepreg tapes to indicate that their use can result in higher production rates of more uniform parts than those made by wet winding.

Hot Dip Galvanizers Offer Cash Awards

Ten awards of $1000 each are being offered for the best ideas developing new applications and markets for hot dip galvanizing.

The American Hot Dip Galvanizers Assn., sponsoring the program in cooperation with the American Zinc Institute, emphasizes that it is "not a contest, but a search for ideas."

The awards will be presented for ideas pertaining to: 1) applications of hot dip galvanizing to a new or unusual field, 2) improvements in present applications or, 3) new methods of after-treatment for hot dip galvanized products.

Entries should be sent to the American Hot Dip Galvanizers Assn., 5225 Manning Place, NW, Washington 16, D. C.

Summer Courses in Materials Engineering

Special courses in materials science and engineering are being offered to members of industry by several leading universities this summer. This summary supplements the description of other courses in M/DE, Mar '61, p 22.

University of California, Los Angeles — *Structural Sandwich Design and Fabrication (July 10-21)* will cover the fundamental design and fabrication concepts of various types of construction. Included will be discussions of facing materials requirements, adhesives and cores, efficiency of constructions, and testing procedures.

Case Institute of Technology—*Melting and Solidification Behavior in Investment Casting (June 20-21)* is sponsored by Investment Casting Institute. Lectures will discuss melting and solidification of metals and application of these principles to investment casting, metal-mold reactions, heat flow in refractory-molten metal atmosphere systems.

Illinois Institute of Technology —*X-Ray Diffraction Analysis (June 12-23)* will provide training in the use of x-ray diffraction methods for analysis of commercial materials on both beginning and advanced levels.

Massachusetts Institute of Technology—*Materials Science (June 13-23)* will present an overall view of materials science in course rather than conference form. Emphasis will be placed on the unifying interrelationships between the fine structure of materials and their properties. Some of the topics will be: dislocation and point imperfection theory, ultra-high strength materials, high temperature metals and ceramics, semiconductors, masers and microwave devices, and radiation effects. *Technology of Reinforced Plastics (June 19-23)* will examine the most recent advances in the field of fibrous glass-reinforced plastics. Among the topics: glass-polymer interface reactions, adhesion, influence of resin characteristics, long-time mechanical behavior, and test methods. *Engineering Principles of Textile Materials (June 19-23, June 26-30).* The first week's program will summarize the elements of textile structural mechanics. The second week's advanced program is planned for those who have worked in depth in specific areas and who now want to consider recent developments in the general field. *The Science of Adhesion (June 26-30)* will review new knowledge about the nature of adhesion and its application. Subjects include: solid surfaces, theory of adhesive joints, adhesive tapes, wetting, tackiness, setting, and adhesion in reinforced joints.

Ohio State University—*Fundamentals of Welding Engineering (June 12-23)* is intended to provide engineers, supervisors and technicians with a fundamental understanding of welding processes, product design, production techniques, testing, and quality control.

Pennsylvania State University—*R&D Management Development Seminar (June 25-30)* will emphasize the human relations skills needed by intermediate managers, such as project engineers, supervisors and leaders, in research and development organizations. *Materials under Thermal Stress Seminar (Aug 27-Sept 1)* will present an intensive treatment of thermal stress analysis and interpretation. Topics will include: elastic analysis, fundamental behavior or materials under mechanical and thermal strain cycling, and choice of materials and mechanical configurations for optimum design.

Managing Materials Research

The first in a new series of conferences designed to help those concerned with management of materials research and engineering will be held at Harriman, N. Y., May 17-19.

The conference, sponsored by The Metallurgical Society of AIME, will include lectures by leading research managers and authorities on the principles of management; case history clinics; and workshop groups.

Write: Mr. D. C. Johnson, The Metallurgical Society of AIME, 29 W. 39 St., New York 18.

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Coming Meetings

LUBRICATION SYMPOSIUM, American Society of Mechanical Engineers. Miami Beach, Fla. May 8-9.

CASTINGS CONGRESS & EXPOSITION, American Foundrymen's Society. San Francisco. May 8-12.

PRODUCTION ENGINEERING CONFERENCE, American Society of Mechanical Engineers. Toronto. May 10-12.

MANAGEMENT OF MATERIALS RESEARCH CONFERENCE, The Metallurgical Society of AIME. Harriman, N.Y. May 17-19.

AMERICAN SOCIETY OF TOOL AND MANUFACTURING ENGINEERS CONVENTION, Exposition of Creative Manufacturing Equipment. New York. May 22-26.

DESIGN ENGINEERING CONFERENCE, Machine Design Div., American Society of Mechanical Engineers. Detroit. May 22-25. *(Preview p 163)*

DESIGN ENGINEERING SHOW, Clapp & Poliack, Inc. Cobo Hall, Detroit. May 22-25. *(Preview p 163)*

9TH NATIONAL PLASTICS EXPOSITION AND CONFERENCE, Society of the Plastics Industry. New York City. June 5-9. *(Preview p 173)*

MALLEABLE FOUNDERS SOCIETY, annual meeting. Colorado Springs, Colo. June 8-9.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, annual meeting. Los Angeles. June 11-15.

PLASTICS IN PACKAGING, Society of Plastic Engineers, regional conference. Montreal. June 14.

INTERNATIONAL POWDER METALLURGY CONGRESS. Reutte, Austria. June 20-24.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting. Atlantic City, N.J. June 25-30.

VACUUM METALLURGY, Sponsored by American Vacuum Society and New York University. New York City. June 26-27.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, annual meeting. Seattle. July 4-7.

SEMICONDUCTOR CONFERENCE, American Institute of Mining, Metallurgical and Petroleum Engineers. Los Angeles. Aug 30-Sept 1.

AMERICAN CHEMICAL SOCIETY, national meeting. Chicago. Sept 3-8.

ENGINEERING MANAGEMENT CONFERENCE, American Society of Mechanical Engineers and American Institute of Electrical Engineers. New York City. Sept 14-15.

HIGH TEMPERATURE CERAMIC-ON-METAL PROCESSES CONFERENCE, American Ceramic Society. Columbus, Ohio. Sept 20-23.

Selas saves thousands of maintenance hours on combustion controls

Reevecote synthetic diaphragm goes into place on pressure governor section of Selas Combustion Controller. Reevecote has more than doubled the service life of diaphragms on these units.

with REEVECOTE SYNTHETIC DIAPHRAGMS

By switching from leather to synthetic diaphragms of Reevecote in its Combustion Controllers, the Selas Corporation of America saved thousands of maintenance hours. They also improved the accuracy of these units.

Problem: Originally, leather diaphragms were used in the mixing valve and in the pressure governor of the compressor. These two diaphragms required the most frequent maintenance of all parts in the unit. The leather had a tendency to dry out, stiffen and crack. Accuracy was impaired. The leather required frequent oilings and service life was limited to less than 12 months.

Solution: Selas switched to synthetic diaphragms of Reevecote 7134 and 7028, made by the Vulcan Rubber Products Division of Reeves Brothers, Inc. After 2 years of service, diaphragm maintenance has been practically nil. The Reevecote diaphragms retained their flexibility, did not dry out, required no oiling. Accuracy improved and thousands of maintenance hours were saved.

If *your* design calls for any type of diaphragm – any use of coated fabrics – choose from over 200 styles of Reevecote – the most complete line of synthetic coated fabrics for industry. Write for new Reevecote Catalog.

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Reeves Brothers, Inc., Vulcan Rubber Products Division
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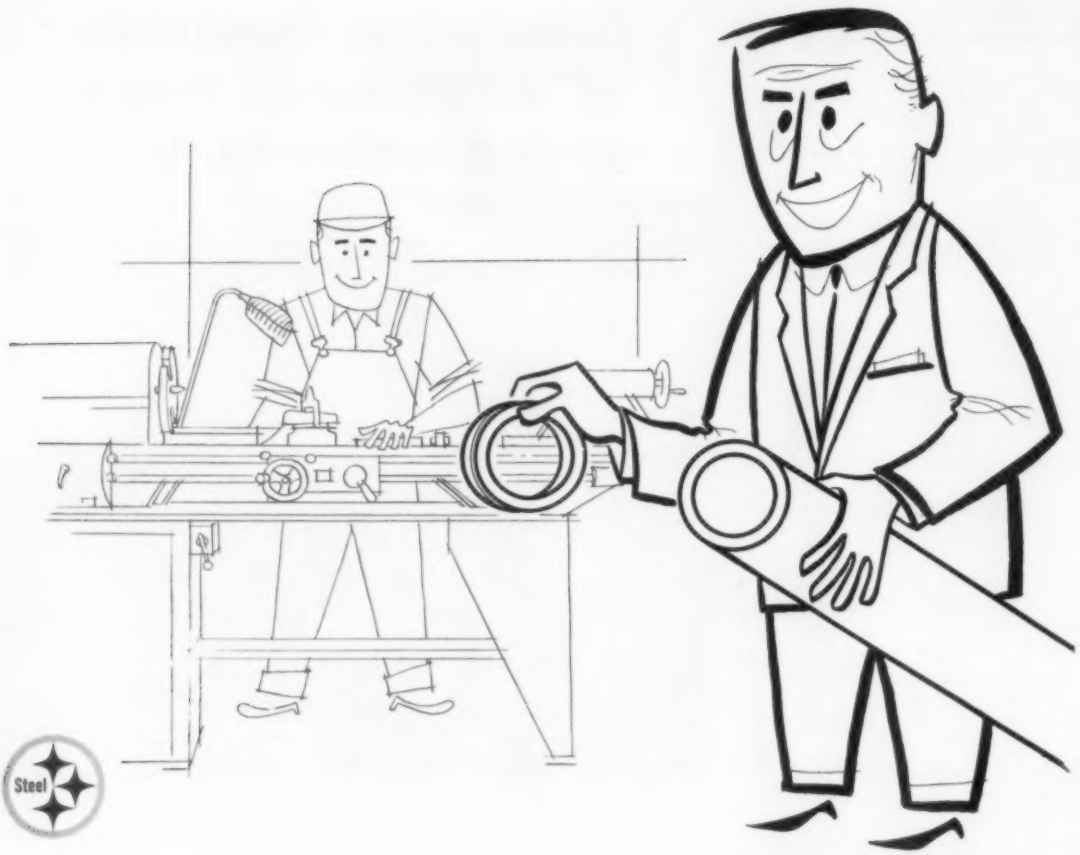

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Do you consider tubing as a semi-finished product? It can be. In fact, when you start with the right B&W tube many end products require only finish machining—others need no machining at all.

Here's why. B&W seamless mechanical tubing is job-matched to your end-use application and production equipment. Desired finish, heat treatment, tolerances, alloy factor and steel quality are built into the tube to bring it as close as possible to the finished part. What's more, properties are uniform from tube to tube. You get fewer rejects —a more machinable tube in high-speed machining operations.

Interested? B&W mechanical tubing is available from Steel Service Centers around the country and through your B&W District Sales Office. Or write for Bulletin T-430. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

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Technical translations

To the Editor:

I heartily endorse all you have to say about the need for wider dissemination of European technical data (M/DE, Jan '61, p 166) and I certainly wish you well in any further efforts you or your magazine may make in achieving this wider dissemination.

Your proposal that more European journals be translated into English seems a rather drastic one, and certainly an expensive one, as you point out. It seems to me that a great many less extensive things could be done to improve the situation greatly.

You point out that technical men, for the most part, cannot read foreign languages and that even if they could, European publications are not readily available to them. The second complaint, it seems to me, can be easily remedied: library users should demand that the libraries that serve them subscribe to foreign journals. Or the individuals could subscribe to them. In general, there is no problem in subscribing to at least West European periodicals.

The general level of language training in this country has come in for considerable discussion and criticism recently, and I hope that some reforms in our educational system will occur so that language study receives more emphasis. Starting to train those presently in school still won't help those out of school, of course; but I believe that even engineering colleges should begin requiring some foreign language ability for graduation. Most of those already out of school could gain sufficient reading ability to digest the important points in foreign articles if they are given sufficient motivation.

Magazines such as yours can do a great deal themselves by carrying summaries, or abstracts, or just passing mention of articles of interest in their field that appear in foreign journals. Perhaps some kind of cooperative arrangement could be made with foreign journals to furnish advance information, or even English summaries of articles to be published.

It does not seem to me that translation services are so hard to come by except in unusual circumstances. Many technical libraries, particularly of government and industrial laboratories, have staff translators. There is no shortage of commercial translation agencies, although their services sometimes seem expensive.

JOHN M. TAYLOR, JR.
Scientific Staff Assistant
Office of Naval Research
U. S. Navy Underwater Sound
Reference Laboratory
Orlando, Fla.

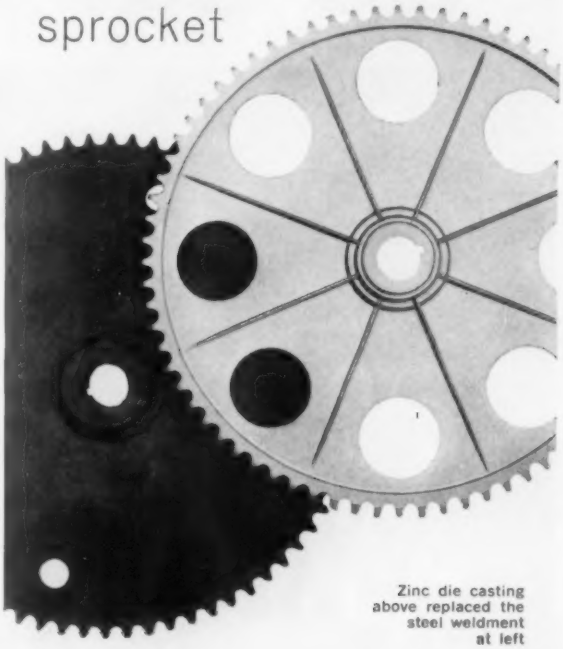
To the Editor:

I fully agree with the thoughts expressed in your recent editorial on the need for translations of European technical publications. However, I doubt whether cover-to-cover translations would justify the great effort involved. The proper selection of articles to be translated and abstracts would be of greater service to the engineer. The initiative should come from interested branches of industry.

V. MARCILGER
East Orange, N. J.

(more Letters on next page)

ADVANCE put
teeth *
into reducing
the cost of this
sprocket



Zinc die casting above replaced the steel weldment at left

*
By "teeth" we mean Advance engineers bit deep into the cost of the 12-inch steel weldment sprocket shown above and came up with a **saving of better than 50%** in converting it to a zinc alloy die casting.

The sprocket drives the rotating drum of an industrial clothes dryer. Both pitch and O.D. are held to .010 tolerance. Interchangeable cores and inserts readily produce this sprocket with ¾ or 1 inch bore.

Whether it's a conversion, or a die casting of completely new design, putting "teeth" into a die casting cost problem is what Advance engineers like most to do.

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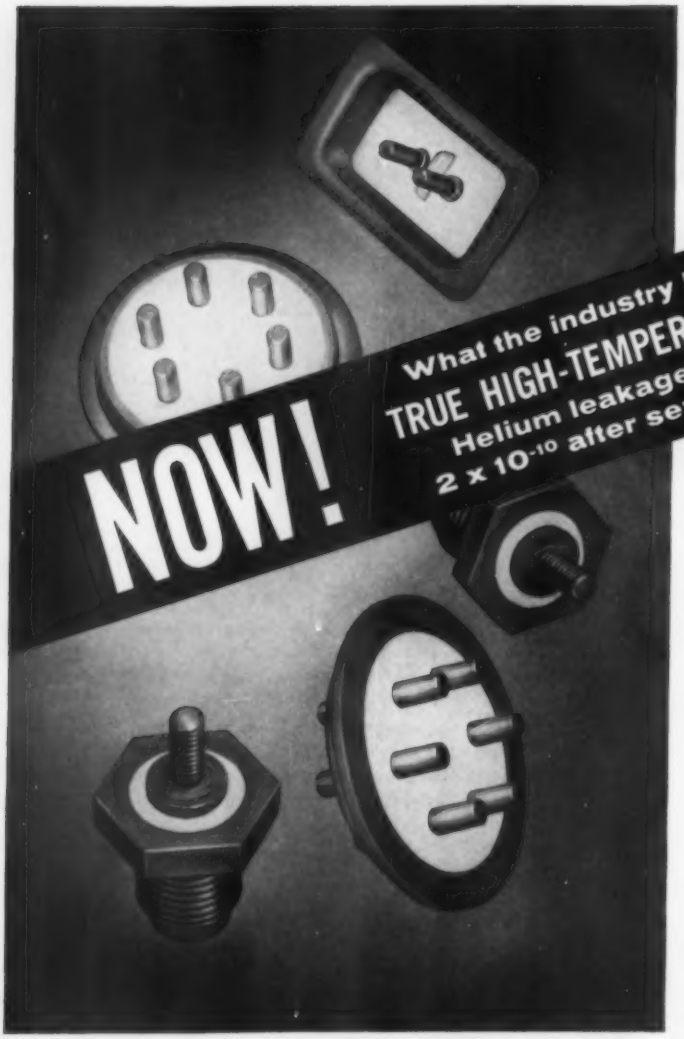
BIG NEWS in high-temperature precision-molded insulation

SUPRAMICA® 620 "BB" ceramoplastic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What the industry has been waiting for...
TRUE HIGH-TEMPERATURE HERMETIC SEALS
Helium leakage rate cc/sec. less than
2 x 10-10 after severe environmental tests.

Need a precision-molded insulation material with total dimensional stability under the most adverse thermal cycling, operating to 1200°F. . . . or a material with previously unattainable combination of properties? Check these facts about new SUPRAMICA 620 "BB" ceramoplastic:

- **Maximum temperature endurance of material 1200°F. (unstressed). Heat distortion temperature of material 1100°F. (ASTM D648-264 PSI)**
- **SUPRAMICA 620 "BB" ceramoplastic can be precision molded to most intricate geometries with gauge-like tolerances.**
- **SUPRAMICA 620 "BB" ceramoplastic will not carbonize.**
- **Absolute hermetic seals achieved directly during the molding cycle. Components meet a helium leakage rate of less than 2 x 10^{-10} cc/sec., after the following environmental tests:**
  1. **Samples heat shocked a total of 20 cycles from boiling water for 30 minutes directly to ice water for 10 minutes.**
  2. **Samples heat shocked a total of 5 cycles, from 350°C. for 1 hour directly to room temperature for 10 minutes, to -70°C. for 1 hour, to room temperature for 10 minutes.**
  3. **Samples heated to 500°C. for 4 hours and directly to room temperature.**
- **Thermal expansion factor matches many metals and alloys.**
- **New SUPRAMICA 620 "BB" ceramoplastic features a dielectric strength of 270 volts/mil, 1/8" thickness per ASTM D-149.**

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Tubing for use in human body

To the Editor:

I am interested in learning the names of individuals and/or concerns to whom I might address inquiries concerning the fabrication of small rubber or distensible plastic tubing to be introduced into the blood vessels of patients. In general, I am looking for tubing of high flexibility and an o.d. of approximately 0.05 to 0.1 in. I do not have detailed specifications since the application is unique. In the past, I have made use of a supply of surplus rubber-coated insulation. The material was far from ideal and the source has been exhausted. Can you help me?

A second reason for writing is to ask whether you know the name of a national society devoted to materials in design engineering that holds annual meetings. In addition to the problem on tubing, there are a number of other important problems in a similar vein where our studies have run into blind alleys. That the alleys are not truly blind is evidenced by reading M/DE. It occurred to me that perhaps I might contact the offices of such a society relevant to my participation in a meeting. Were I to state a few of the design problems for a mixed audience such as I seek, I am convinced there would be prompt and entirely effective response.

CHARLES T. DOTTER, M.D.
Professor and Chairman
Department of Radiology
University of Oregon Medical School
Portland, Ore.

We have given Dr. Dotter what aid we could; perhaps our readers can supply some further information.

Plastics in outer space

To the Editor:

I am a junior at Manchester High School taking college chemistry and was assigned a term paper on "Vinyls and Plastics Used on Outer Space Vehicles."

I would appreciate it if you would send me any information you may have on such things as rocket liners, nose cones, plastics used on the interior of space vehicles, etc.

LEE J. TURNER
Akron, Ohio

We don't mind helping, but the "etc." was a bit much.

It sometimes takes a while, but . . .

To the Editor:

We wish to point out that you have spelled the name Terafilm incorrectly three times in your article "New Polyester Film for Packaging and Electrical Uses" (M/DE, Jan '61, p 15). I don't suppose there is anything you can do at this late date.

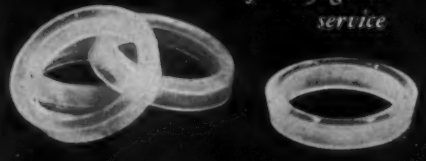
MELVIN WAGNER
Vice President
Acme Backing Corp.
Stamford, Conn.

Between January and April we learned how to spell it; for proof see p 19 of the April issue.

NEW!

INJECTION MOLDED TEFLON*

for cryogenic service



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The FEP Teflon-seated valve poppet, top, provides positive, no-leak sealing under repeated actuation in helium service at 3,000 psi and 320° below zero F. Injection-molded FEP Teflon parts like the lip seals, bottom, have no internal stresses. They have better surface finishes and greater dimensional uniformity than machined parts. They are an economical solution for a variety of problems in the extreme low-temperature field.

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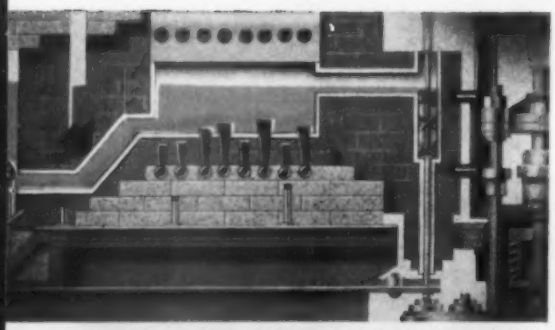
Where any metal but Platinum



PLATINUM DOES BETTER FOR LESS. In this hot end of the Bausch & Lomb continuous-flow furnace only platinum has the stamina to stand up long enough to return a profit. It is used as a lining material and in agitators and thermocouples.

It seemed preposterous at first. Line even part of a 5-ton capacity furnace with platinum? . . .

But the engineers at Bausch & Lomb had a case and proved it. The only *sure* way to contain glass at volcanic heat for month after month is in platinum.

The proof? Platinum melts at 3224°F (1770°C). Retains adequate strength at ophthalmic glass refining temperatures (2600° - 2700°F). Doesn't dissolve in the melt to discolor, or degrade quality. Doesn't erodé or corrode in molten glass stream.

No other material provides the consistent purity essential to the economical mass-production of quality lenses.

The metal that masters molten glass may master a problem for you.

Where conditions involve high temperature and product purity, as in the production of lens glasses; or require peak catalytic efficiency, as in the refining of high octane gasoline; or a combination of severe corrosion and erosion must be met, as in the case of rayon production: or hard, highly con-

Platinum-lined five-ton furnace continuously fills molds with ophthalmic glass at Bausch & Lomb, makers of fine optical products. Furnace goes 18 months without shutdown. Glass must pass 23 quality tests.

would cost too much...

ductive surfaces, as in the production of printed electrical circuits; and many other products, the platinum metals have proved to be most economical.

Progress in research and development indicates a growing need for materials to cope with higher temperatures, higher pressures, more severe combinations of operating conditions . . . materials of proven ability to deliver long, trouble-free service life. To this end the unique potentials of the six platinum metals are being thoroughly explored on a continuing basis.

Platinum, palladium, ruthenium, iridium and rhodium *all* have unique properties, well worth your attention. Specialists are prepared to work closely with you in evaluating these metals for new commercial and scientific uses.

As a first step, write us for additional data on the unusual properties and successful applications of the six platinum metals and their alloys — indicating your field of interest or how we might be of assistance.

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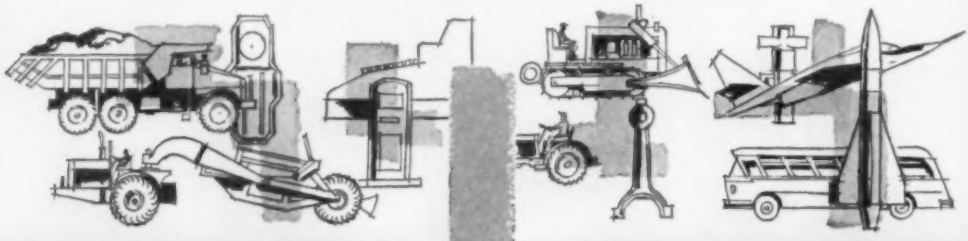

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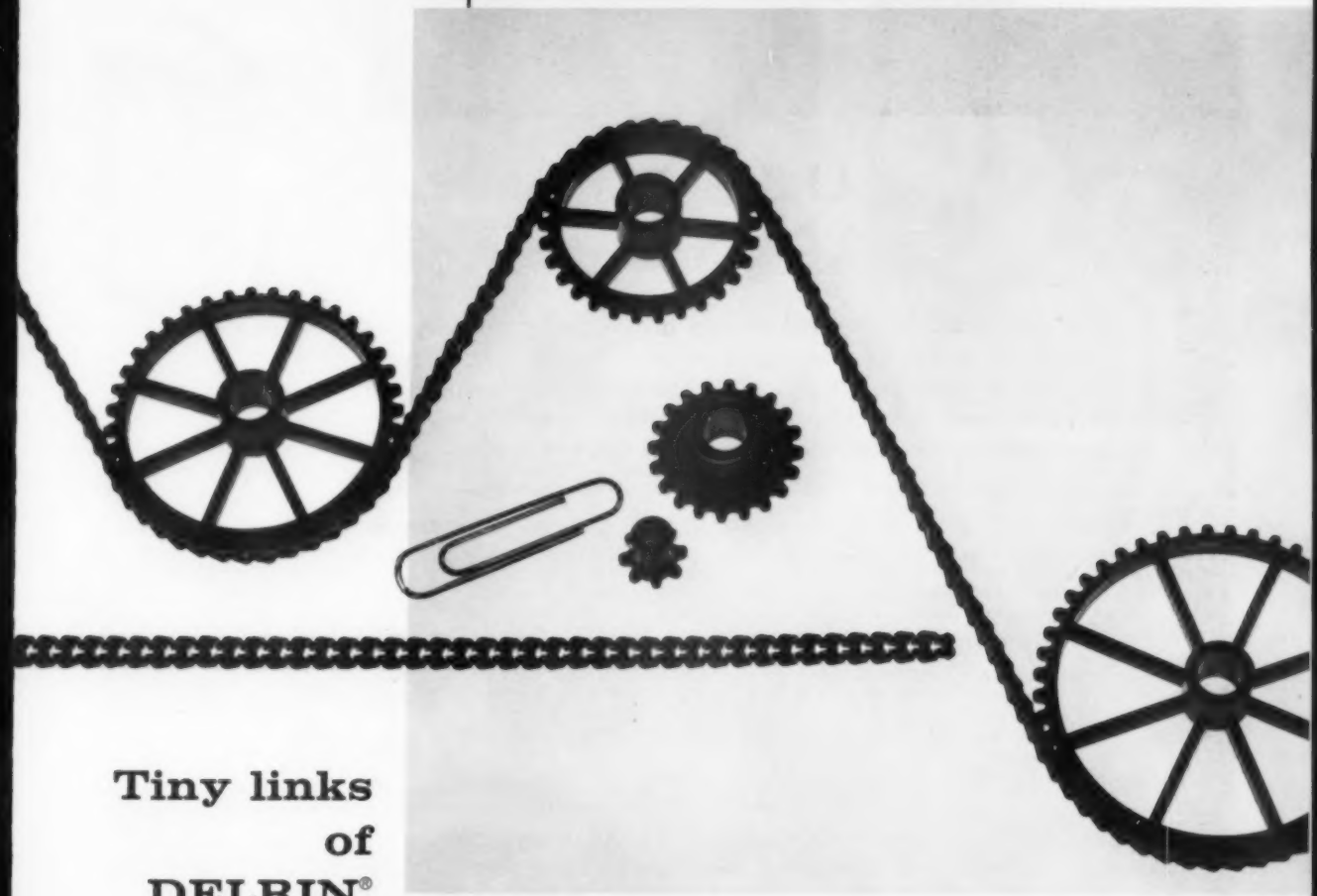

Tiny links of DELRIN® make a remarkable miniature chain

These miniature chains and sprockets are significant examples of the way Du Pont DELRIN acetal resin provides superior performance in application areas once reserved for metals. The chain of snap-fit links is made possible by the strength, stiffness and resilience of DELRIN. The need for a master link is, therefore, eliminated, making the chain adjustable in ⅛ inch increments. The chain weighs only 1 oz. per 15 ft.—one-fifth the weight of similar steel chain. It is factory-tested; momentary tension load at 7 lbs.; and running loads to 2 lbs. Manufacturer's service-life tests show a work rate transfer of 0.06 HP for 10 hours . . . 50 foot-tons of work per inch of chain. The chain is solvent-resistant, prelubricated, non-magnetic and non-conductive. These drive components were designed to fill a need in miniature mechanics and instrumentation in a wide variety of high-speed, low-inertia mechanisms.

The manufacturer, Bohannon Industries of Colorado Springs, Col., reports that of the many materials tested, only DELRIN was adaptable to the intricate technology involved in the development of these miniature drive components.

The unique combination of properties offered by DELRIN solve a variety of design problems in areas as diverse as automobile handles and electronic switches. On the reverse side, you will find additional examples of product improvements made possible by this versatile material.

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BETTER THINGS FOR BETTER LIVING THROUGH CHEMISTRY

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Long-wearing parking-brake cable pulleys of DELRIN® are being used by a leading car manufacturer. The full-radius groove in DELRIN provides natural mating, maximum contact area with the cable . . . eliminates the cable pinching caused by split-type steel pulleys. The new pulleys molded of DELRIN have been tested under severe long-term conditions of high load and temperatures.

Jet injector unit for shallow-well system is molded in three parts of DELRIN and joined by two "one-direction" snap-fits, giving permanent assembly. The new unit outwears bronze by a factor of 2 under sand abrasion . . . molded threads utilize high shear strength of DELRIN acetal resin. (Molded by American Molding Company, San Leandro, for Jacuzzi Bros., Inc., Richmond, California.)

Thumbwheel of this unique multi-deck rotary switch is molded of tough, abrasion-resistant Du Pont DELRIN. A single ¼ inch thumbwheel of DELRIN provides the mechanical and electrical insulating properties needed to handle a combination of rotary switches. (Molded by Par-A-Mount Tool & Mfg. Co., Inc., Chesterton, Indiana, for Chicago Dynamic Industries, Precision Products Division, Chicago, Ill.)

DELRIN® has the strength and toughness to meet rugged mechanical requirements

When a part must function reliably under rugged usage, the strength, stiffness and toughness of DELRIN acetal resin may well provide an economical solution. Parts molded of DELRIN retain a high degree of their mechanical properties under numerous conditions, including broad temperature ranges (–40°F. to 250°F.), humidity, solvents and stress.

Already, many hundreds of designs taking advantage of the unique properties of DELRIN, and of the cost savings made possible by rapid injection molding, have been put into commercial production. Why not investigate further with a view to your own products and problems? Mail the coupon below for more information.

POLYCHEMICALS DEPARTMENT

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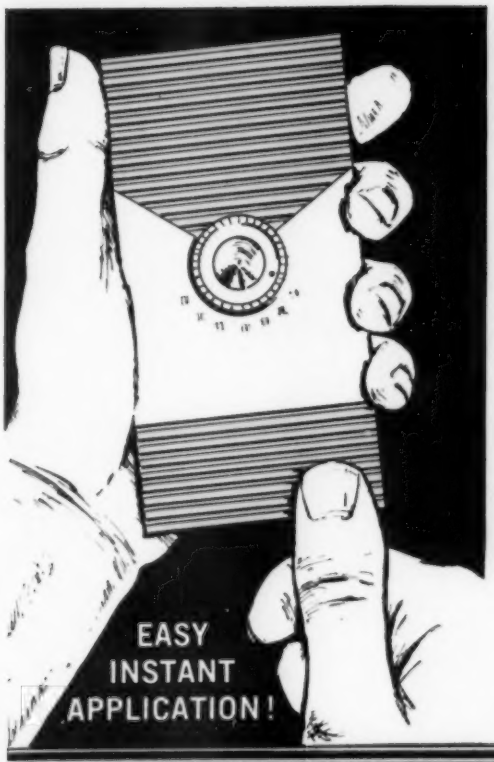

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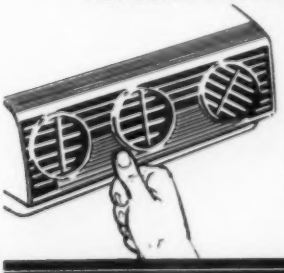

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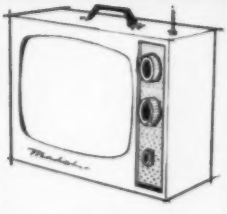

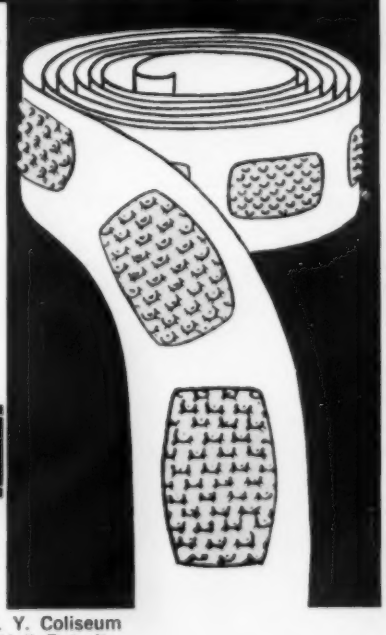

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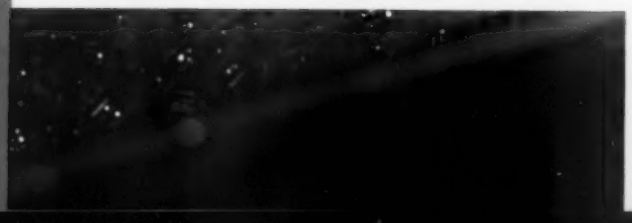
Get all these advantages with leaded carbon and alloy steels from Youngstown. Get fast, dependable delivery from your Steel Service Center, and through 28 Youngstown offices. Get quality, get performance, get leaded steel from Youngstown who knows how to make lead behave inside steel.

Youngstown – growing force in steel



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High Temperature Ceramic Fiber. Carborundum Co., Research & Development Div., Ceramic Fiber Project, 8 pp, illus. Properties, available forms and current uses of a ceramic fiber designed to withstand operating temperatures up to 2300 F. **134**

Metallic, Nonmetallic Forms. Dumont Mfg. Corp., 28 pp, illus. Information on honeycomb sandwich structures, metal-to-metal bonded parts, high temperature molded plastics, special purpose fiberglass laminates and hand lay-up custom moldings. **135**

Felt Design Book. Felters Co., 24 pp. Information on design properties of felt, descriptions of special treatments, and data on how to select the proper shapes and dimensions for specific applications. Also included are data on felt lubrication seals, gaskets, wicking and filters. **136**

Specialty Papers. Knowlton Bros., Inc., 12 pp, illus. Information on technical and industrial specialty papers. Shows company research and manufacturing facilities. **137**

Carbon Parts. Morganite Inc., 12 pp, illus. Chemical and physical properties and sizes of carbon parts. **138**

Carbon and Graphite. Ohio Carbon Co., 8 pp, illus., No. 1164A. Composition, characteristics, properties and applications of carbon and graphite. **139**

Carbon and Graphite. Speer Carbon Co., 8 pp, illus. General advantages, properties, available grades and other information on a line of carbon and graphite products. **140**

Thermal Insulation. H. I. Thompson Fiber Glass Co., chart. Information on thermal insulations for temperatures from —300 F to 3000 F. **141**

Finishes • Cleaning & Finishing

Inspecting Galvanized Products. American Zinc Institute, 32 pp, illus., No. AZI-40. Manual describes significant factors governing inspection, properties, specifications, and purchasing of hot dip zinc coatings. Subjects covered include: thickness and uniformity, coating weight requirements, adherence, embrittlement, warpage and distortion, metallurgical structure of coating, methods of testing, etc. Includes data on product design and a check list of defects, possible causes and recommended action. **142**

Trichloroethylene Finish. E. I. du Pont de Nemours & Co., Inc., Electrochemicals Dept., 4 pp, illus. Information on the advantages, uses, techniques and cost of applying and using a trichloroethylene finishing system. **143**

Polyethylene Coating Resin. E. I. du Pont de Nemours & Co., Polychemicals Dept., 4 pp. Properties, uses and selection factors for a polyethylene extrusion coating resin. **144**

Silver Plating Process. Engelhard Industries, Inc., American Platinum & Silver Div., 12 pp. Characteristics, advantages, operating conditions, deposition rates, and other information on a silver plating process. **145**

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Hard Surfacing Electrodes. Metal & Thermit Corp., Unichrome Finishes & Welding Prod. File cards give data on 88 types and sizes of hard surfacing electrodes and rods. **149**

Zinc, Aluminum Metallized Coatings. Metco, Inc., 4 pp, illus., No. 93XG. Describes six zinc and aluminum metallized protective coatings for use on tanks, electrical parts, bridges and ships. **150**

Fusion Coatings. Michigan Chrome & Chemical Co., 6 pp, illus. Information on small particle size plastics powders for use in fluidized bed coatings. Information also on equipment for fluidized bed coating. **151**

Silicone Coating. Midland Industrial Finishes Co., 4 pp, illus. Properties, application data, corrosion resistance and uses of a silicone coating. **152**

Joining & Fastening

Spring-Tension Fasteners. Associated Spring Corp., 4 pp, illus. Case histories illustrate advantages and characteristics of clamps, clips, latches and locks, pins, retainers, snap rings, hooks and holders, catches, spring washers, hangers, and collars. **153**

Circular Weldments. Dresser Industries, Inc., Dresser Mfg. Div., 8 pp, illus., No. 56-S. Information on facilities and services available for the production of rings and circular weldments. **154**

Glass-Metal Sealing Alloys. Wilbur B. Driver Co., 4 pp. Composition, properties and uses of three glass-to-metal sealing alloys. **155**

Torque Values for Lock Nuts. Elastic Stop Nut Corp. of America, 18 pp, No. 6101. Series of tables list specific recommended installation torque values for thin and standard height stop nuts. Also discusses factors to be considered in selecting a tightening torque, and effects of lubricants. **156**

Threaded Inserts. Heli-Coil Corp., 12 pp, illus. Advantages, sizes and uses of various types of threaded inserts. **157**

Self-Locking Locknuts. Klincher Locknut, Inc., 4 pp, illus. Advantages, characteristics, typical uses, sizes, and specifications for a line of self-locking locknuts. **158**

Adhesives. Raybestos-Manhattan, Inc., Adhesives Dept., 1 p. Large chart gives general descriptions, characteristics, solvents used, typical applications, and bonding requirements of a line of synthetic adhesives. **159**

Pressure - Sensitive Adhesives. Rubba Inc., 3 pp, Nos. R-449, 483. Advantages, characteristics, suggestive uses and other information on a pressure-sensitive adhesive. **160**

Set Screws. Set Screw & Mfg. Co., 28 pp, illus., No. 21. Information on self-tapping and stainless steel set screws. **161**

Fasteners. Simmons Fastener Corp., 42 pp, illus., No. 1257. Sizes, installation data, characteristics and uses of plastics and metal fasteners. **162**

Self-Locking Swage Nut. Standard Pressed Steel Co., Aircraft Missile Div., 4 pp, illus., No. 2701. Specifications, installation and performance data, sizes, and other information on a self-locking swage nut. **163**

Self-Locking Blind Nut. Standard Pressed Steel Co., Industrial Fastener Div., 6 pp, illus., No. 2681-660-25C-SPS. Advantages, characteristics, typical uses, and specifications for a one-piece self-locking blind nut. **164**

Speed Nuts. Tinnerman Products, Inc., 18 pp, illus., No. 353. Seventeen case histories describe assembly saving achieved through the use of Speed Nut mechanical fasteners. **165**

Blind Rivets. Townsend Co., Cherry Rivet Div., 12 pp, illus., No. TCL-160. Specifications, selection factors, material thickness guide, and other information on structural and nonstructural rivets for aluminum, mild steel and monel. **166**

Nickel-Base Brazing Alloy. Wall Colmonoy Corp., Stainless Processing Div., 1 p, No. 2.1.4. Composition, metallurgical properties, oxidation resistance, joint strength, typical uses, methods of application, and other information on a nickel-base brazing alloy. **167**

Nylon Screws. Weckesser Co., 3 pp, illus. Installation data for black nylon screws and nuts. **168**

Methods & Equipment • Testing

Hardness Tester. Wilson Mechanical Instrument Div., American Chain & Cable Co., Inc., 2 pp, illus., No. TT-58. Dimensions, features, operational data and prices of a Rockwell hardness tester. **169**

Vibration Dampeners. Firestone Industrial Products Co., Div. of Firestone Tire & Rubber Co., 32 pp, illus. Design data and technical information on vibration dampeners. **170**

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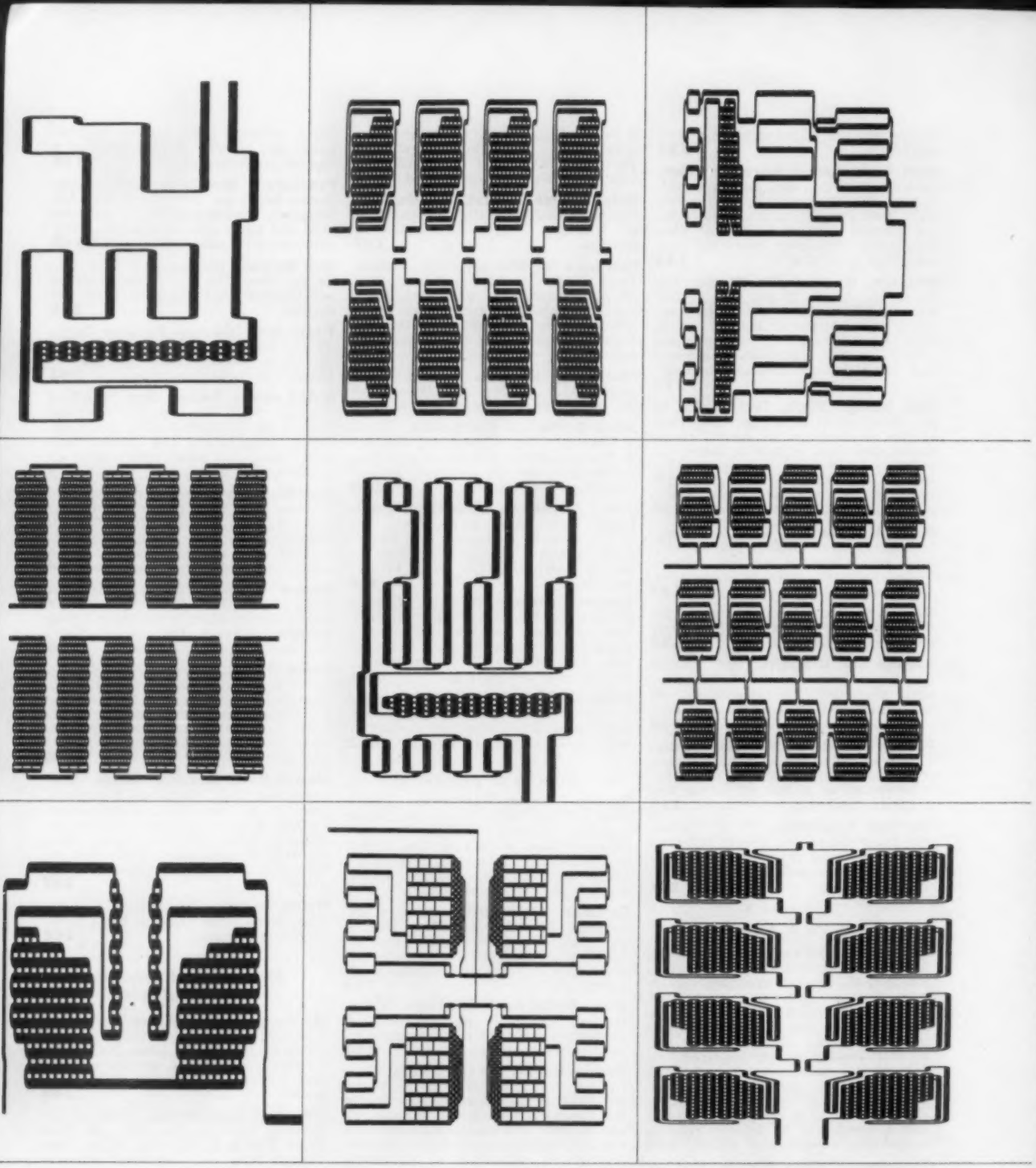

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TECHNICAL LITERATURE

(cont'd from p 45)

Books

Reactor Handbook, Vol. I: Materials. *Edited by C. R. Lipton, Jr. Interscience Publishers, Inc., New York. 1960. Cloth, 7¼ by 10 in., 1207 pp. Price $36.50*

Reviewed by K. J. Krystyan*

This up-dated version of the *Materials* volume not only includes considerably more information but incorporates an improved, easier-to-use format.

The editor has done an excellent job of tying together the contributions from over 100 different experts, and the book should prove immensely useful as a ready reference to those working in the field of nuclear energy who require detailed information on reactor materials. It should also provide a good introduction to materials engineers who are not familiar with the many problems associated with reactor applications of materials.

Approximately 55% of the volume is concerned with fuels, and cladding and structural materials. Shielding and control materials each comprise about 10% of the contents, with the remainder divided approximately equally between moderator and coolant materials.

An appendix lists references to constitutional diagrams of binary alloy systems, and a generous bibliography is included for more detailed information in both classified and unclassified areas. In addition, each section is prefaced with a brief introduction and each chapter has a separate contents list.

Specific materials covered

Specific materials covered under each of the major sections include: *Fuel Materials*—elemental metals (such as uranium, thorium, plutonium, and their alloys); ceramics; dispersion fuel systems in various matrices; and liquid metal, aqueous, and molten salt systems. *Cladding and Structural Materials*—all metals and alloys from aluminum to zirconium, as well as special purpose alloys and materials for valves and bearings. *Control Materials*—hafnium, boron, cadmium, silver, and rare earths, including a necessarily abbreviated, though worthwhile, discussion of the nuclear physics of these materials. *Moderator Materials*—light and heavy water; graphite; beryllium (its alloys and compounds); various organic materials; and hydrides and hydroxides. *Coolants*—gas and liquid metal coolants (water and organic coolants are covered in the section on moderator materials). *Shielding Materials*—a review, principally in tabular form, of the nuclear, physical, and mechanical properties of dozens of materials.

Chapters on Radiation Damage of Shielding Materials and Bulk Shielding Data conclude the book.

Suggestion for future

Additional data should be included in future editions on the effect of transmutation products on the properties of materials.

Source Book of the New Plastics: Vol. 2. *Herbert R. Simonds. Reinhold Publishing Corp., New York. 1961. Cloth, 6¼ by 9¼ in., 310 pp. Price $8.95*

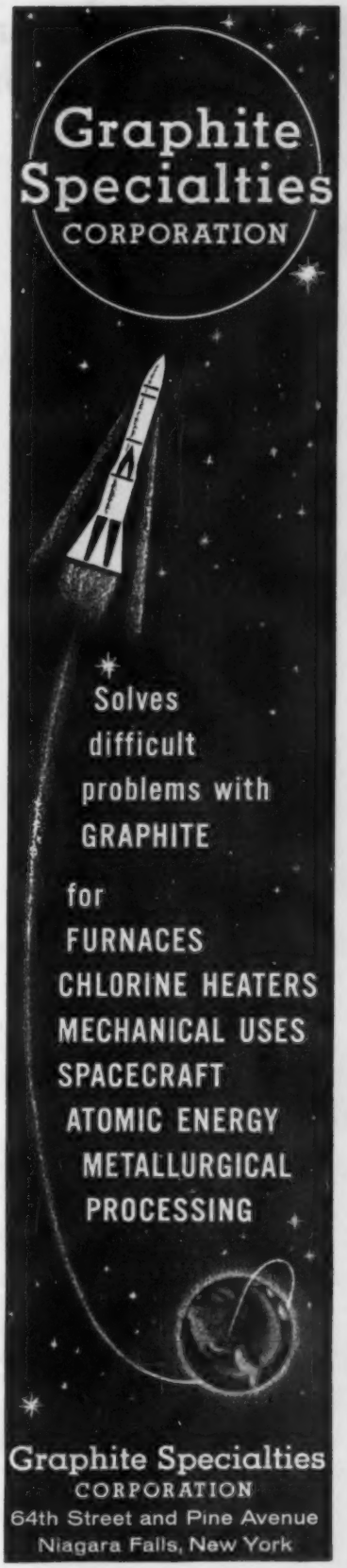
Beginning where Volume 1 left off, this new edition in Reinhold's "Source Book" series covers new materials and processes in the plastics industry through most of 1960. It discusses properties, production, prices, applications and selection of important new plastics.

Of special interest is the chapter on recent technical progress, which includes articles on stereospecific catalysts, block and graft polymers, fluorocarbon nomenclature, and urethane foams.

Principles of Manufacturing Materials and Processes. *James S. Campbell, Jr. McGraw-Hill Book Co., New York. 1961. Cloth, 6¼ by 9¼ in., 674 pp. Price $9.75*

This engineering text, which may also prove handy for practicing engineers, surveys the subject of manufacturing materials and processes by first indicating the basic principles

*Materials Engineer, Knolls Atomic Power Laboratory.



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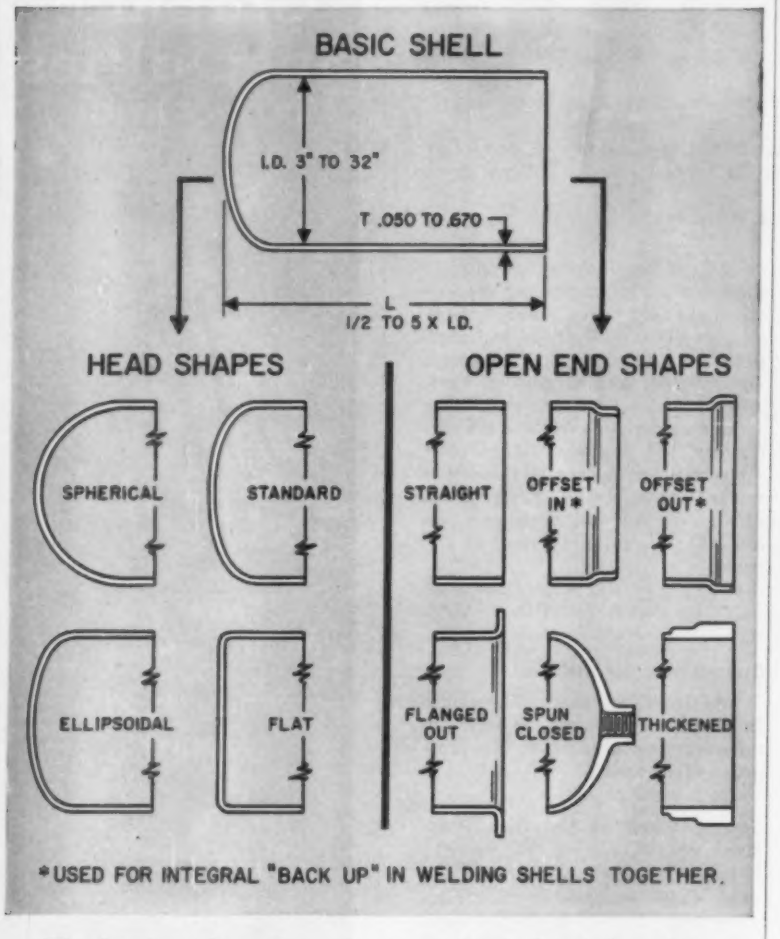

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TECHNICAL LITERATURE

involved and then tying them in with chemistry and physics.

Among the many subjects covered are: measuring and gaging; metallurgy and metals; heat treating; molds and cores for sand castings; solidification, gating, and risering; sand molding; cleaning and finishing; sand casting defects and inspection methods; product development and design of sand castings; other casting processes; powder metallurgy; plastic flow and mechanical working fundamentals; rolling and forging; welding, brazing, and soldering processes; plastics molding and forming; metal cutting; and recent developments in manufacturing processes.

Ceramics. *P. William Lee. Reinhold Publishing Corp., New York. 1961. Cloth, 6¼ by 9¼ in., 210 pp. Price $5.95*

This book, claimed to be the first to present a comprehensive survey of the entire field of ceramics within a single volume, covers the history, raw materials, basic chemistry, and applications of ceramic materials in industry. It also covers such specialized uses of ceramics as electronics, dentistry, high temperature refractories, and low temperature enamels.

Specific subjects include: principal raw materials, ceramic chemistry, whitewares, artware, ceramics for electrical and electronic uses, dental porcelain, structural clay products, refractories, glass, porcelain enamel, ceramic abrasives, cermets, and new developments in ceramics.

High-Frequency Magnetic Materials: Their Characteristics and Principal Applications. *W. J. Polydoroff. John Wiley & Sons, Inc., New York. 1960. Cloth, 6 by 9¼ in., 220 pp. Price $9*

This guide to ferromagnetic materials begins with a discussion of the characteristics of magnetic materials and powders and a description of the tests used to measure them. The author then considers such important applications as ferrinductors, variable inductors for permeability and incremental permeability tuning, and ferromagnetic antennas. Several special applications, including microwave ferrites, are also covered.

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TECHNICAL LITERATURE

magnetic materials, compressed powder cores, losses in high frequency magnetic core materials, effects of temperature on core material characteristics, and resistivity and dielectric properties.

Proceedings of the Second Annual Symposium on Nondestructive Testing of Aircraft and Missile Components. *South Texas Section of the Society for Nondestructive Testing, Inc., and Southwest Research Institute, San Antonio, Texas. 1961. Cloth, 6¼ by 9¼ in., 231 pp. Price $10*

Series of technical papers delivered at a three-day symposium held last February.

Reports

Steel extrusions AVAILABILITY AND MECHANICAL PROPERTIES OF HIGH STRENGTH STEEL EXTRUSIONS. *R. J. Fiorentino and A. M. Sabroff. Defense Metals Information Center, Battelle Memorial Institute. Oct '60. 60 pp. Available from Office of Technical Services, Dept. of Commerce. Washington 25, D. C. Price $1 (PB 151897)*

Information on the availability and mechanical properties of high strength steel extrusions. Typical current extrusion specifications and illustrative mechanical properties are discussed. Some attention is devoted to anticipated future requirements.

Insulating coatings HIGH TEMPERATURE ELECTRICAL INSULATING COATINGS ON WIRE. *D. L. Wilcox and others. University of Illinois. May '60. 75 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $2 (PB 161954)*

This final-phase report of a three-year study of high temperature electrical insulation for wire, discusses the ratio of coating thickness to wire diameter and the wire's cooling cycle as important factors affecting the flexibility of coatings. Studies show that heat treatment can increase coating flexibility.

New welding techniques NEW DEVELOPMENTS IN THE WELDING OF METALS. *P. J. Rieppel. Defense Met-*

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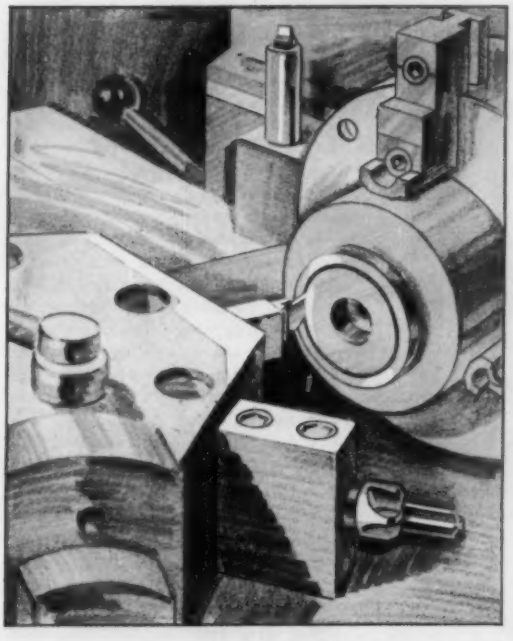

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TECHNICAL LITERATURE

als Information Center, Battelle Memorial Institute. June '60. 50 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.25 (PB 151089)

A survey of the applications and limitations of 14 industrial welding techniques developed since 1956. The report explains how each technique works and comments on the effectiveness of various applications of each. Techniques evaluated are: electroslag welding; short-arc and dip-arc welding; electron beam welding; arc spot welding; high frequency welding; foil seam welding; magnetic force welding; heavy-section brazing; thin-section brazing; special brazing; ultrasonic welding; friction welding; diffusion bonding; and explosive welding.

Creep-rupture ULTRA-SHORT-TIME CREEP RUPTURE, PART 2. *J. S. Ives, Jr., American Machine and Foundry Co. May '60, 131 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $2.75 (PB 161 985)*

Apparatus was developed to heat sheet materials (used in high speed aircraft and missiles) to temperatures up to 3000 F within 200 milliseconds. Creep behavior of eight structural sheet materials at four creep rates for each temperature was examined. Strain vs time, isochronous stress vs strain, and stress vs time curves were plotted. Emissivity data, or data from which emissivity can be calculated, are also given.

Steel fatigue properties STUDY OF FATIGUE PROPERTIES OF ULTRA-HIGH STRENGTH STEEL. *H. B. Nudelman and J. P. Sheehan, Armour Research Foundation, Illinois Institute of Technology. Apr '60, 57 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.75 (PB 171 056)*

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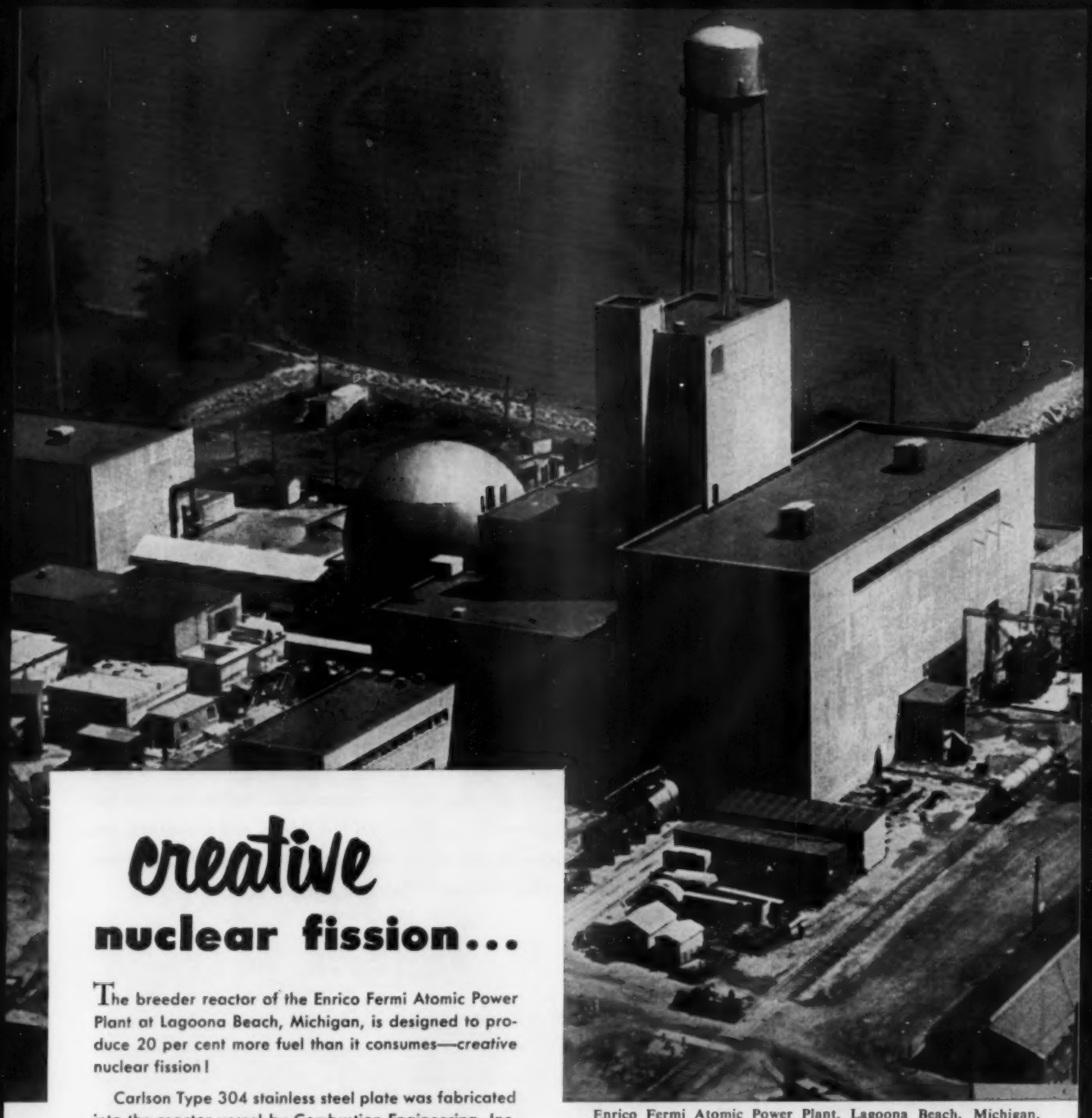

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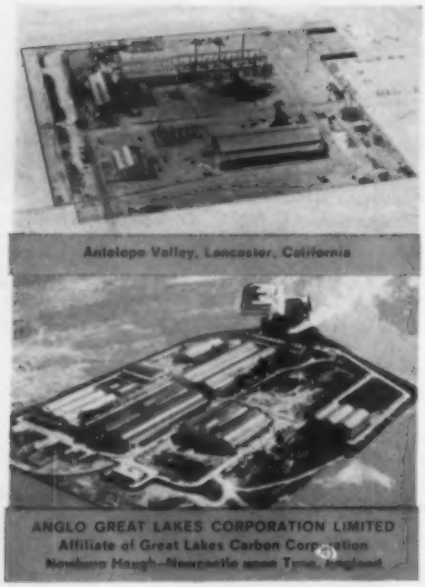

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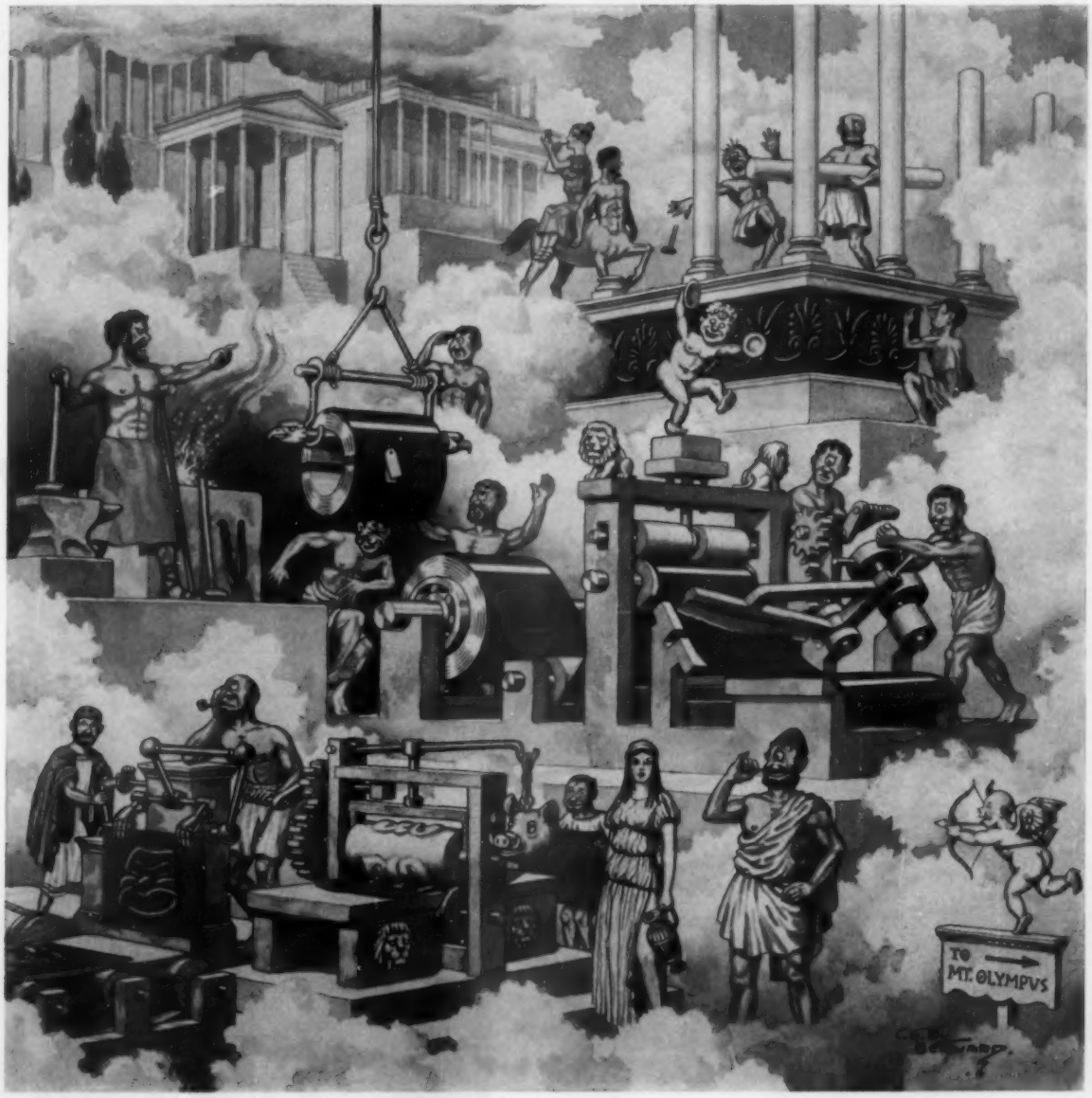

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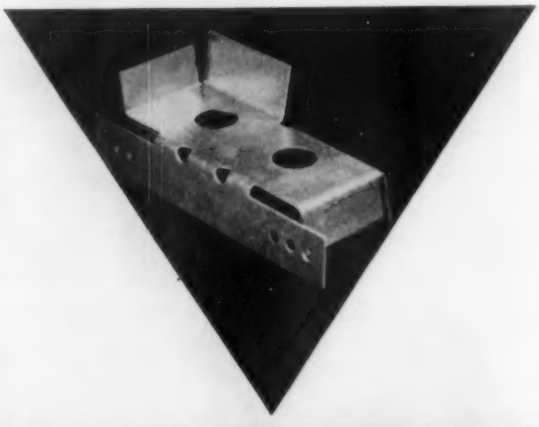
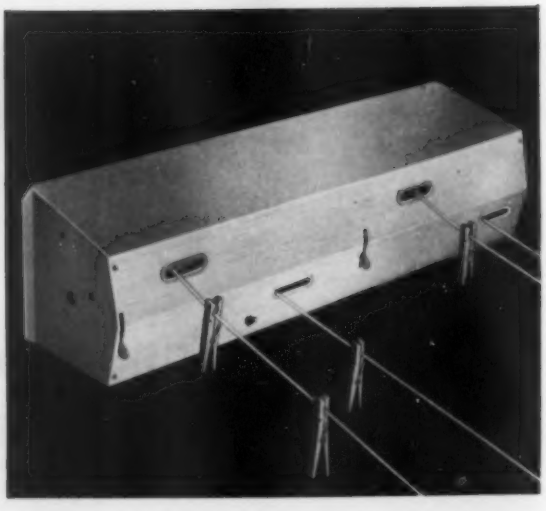
Design for Savings with





At the Design Engineering Show, visit Armco Booth 409-411 — See How "Designing is Saving with Armco Special Steels."

Armco Special Steels

Armco's many special steels offer design savings. Here are 3 examples:

Saves Weight — This new engine packs one horsepower per pound. A prime feature of its lightweight design is a cylinder block assembly formed from Armco 18-8 Stainless Steel *sheets*. Uniformly-thin walls speed cooling, minimize "hot spots" and pre-ignition, permit 14:1 compression ratio on regular gasoline.

Saves Cost for Protection — Today this door clip has greater protection from rust because it is made of Armco ZINCGRIP® Steel. Yet it *costs less* than when made from cold-rolled steel and painted. Consider a switch to Armco ZINCGRIP Steel for parts you now paint or plate.

Saves Material Costs — A design changeover from aluminum to Armco ALUMINIZED STEEL Type 2 for casings resulted in savings of 30% for the manufacturer of "Vanishing Clothesline Dryers." In addition, the new unit has the strength of steel — doesn't dent easily in shipping, according to the manufacturer. Corrosion is no problem, either, because this aluminum-coated steel is made to resist atmospheric corrosion.

Send for more data — For more information on any Armco Special Steel, write Armco Division, Armco Steel Corporation, 1701 Curtis Street, Middletown, Ohio.

Use this label to identify modern, dependable steels in your products.

ARMCO Armco Division

frenchtown engineered ceramics NEWS MEMO

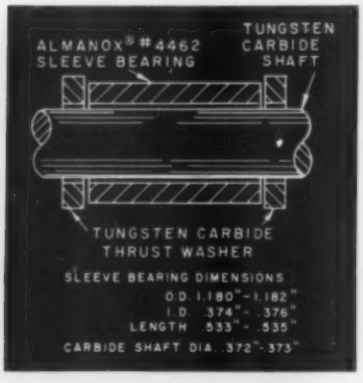
FRENCHTOWN PORCELAIN COMPANY • FRENCHTOWN, NEW JERSEY

Frenchtown solves own bearing problem

Discounting the old adage that a shoemaker's children go barefoot, Frenchtown solved its own bearing problem with the use of the well-known alumina ceramic material, Almanox® #4462.

In the grinding of unfired aluminum oxide spark plug insulator blanks, a daily maintenance operation consisted of replacing steel ball bearing assemblies. The extremely abrasive character of aluminum oxide dust, even in unfired ceramic compounds, reduced the service life of commercial ball bearings to less than twenty hours.

Substituting a sleeve bearing of Almanox® #4462, precision-ground to a clearance of .002", with a tungsten carbide shaft, resulted in a ceramic to carbide



relationship that has stood up for 24 months' service, 80 hours a week. And no lubricant is used; the bearing runs dry! Shaft speed is 800 rpm, driving a back-up wheel 2-1/2" dia. with a 3/4" face.

In addition, Frenchtown Almanox® #4462 is used in a variety of other company production equipment for wear resistant tracks, guides and mechanical parts.

Perhaps you have a plant application wherein a Frenchtown alumina ceramic material can do the job better, at far less cost. Write, telling us about your problem. No obligation, of course.

Frenchtown introduces new line of Feed-through and Terminal Bushings

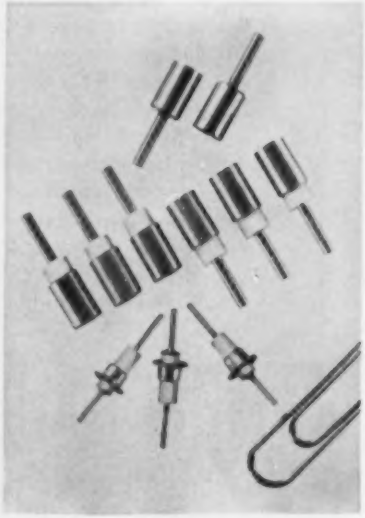
Now available from Frenchtown are four series of fluted terminal bushings and three series of tubular terminal bushings for use where silver solder, brazing, or welding of terminal assembly to container is made necessary by higher operating temperatures than can be withstood by soft solder seals. These new Frenchtown lines are ideal for use by manufacturers of transformers, capacitors, filters, networks, and other large hermetically sealed units.

The insulator bodies are made of 94% alumina, Frenchtown #6536, glazed on external surfaces. All metallized areas are prepared by application of Molcote®, Frenchtown's patented high-temperature metallized coating. The metal hardware consists of nickel iron flanges and caps with fused silver finish. Terminal studs or lugs of cold rolled steel, are nickel plated. Assembly of metallized ceramic with hardware is accomplished by means of pure silver braze. Hermeticity of seals is determined by helium mass spectrometer leak detector. Write for detailed literature. No obligation, of course.

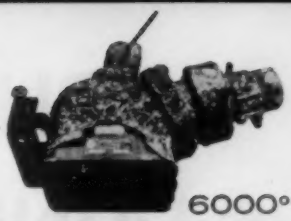
In addition to the new fluted and tubular terminal series, Frenchtown also introduces a new line of miniature feed-through bushings for use on unusually small hermetically sealed units, including temperature control devices and miniature electronic assemblies.

As with the fluted and tubular terminal series, these miniature hollow terminals are made of Frenchtown high alumina ceramic, with Molcote® metallized coating at all joint areas. Metal parts of nickel-iron or pure nickel are assembled with metallized ceramics by pure silver braze. Hermeticity is checked by a helium mass spectrometer leak detector.

The availability of these miniature units should enable the designer to make use of standards not otherwise available. Descriptive literature, complete with dimensional data, sketches, and general engineering information is available upon request. Check the key number shown below, or write us directly.

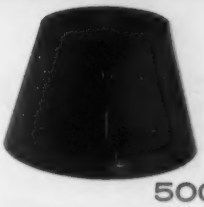


For more information, turn to Reader Service card, circle No. 422



6000° F.

D-6S Flexible coating—A major development in protection from rocket blast. Remains flexible. Easy to paint on at site, scrape off after exposure, and re-apply. Save time, labor. For cables, all exposed flight and ground equipment. In photo, coating has been peeled back to show Cannon Plug intact after exposure to Atlas blast.



5000° F.

Graphite molding compounds—Swift advances in handling of pre-impregnated graphite fabric in new resin systems is widening design possibilities for high temperature and ablative applications. For nozzles, exit cones and blast tube insulation. Withstands flame of solid propellant motors.

1750° F.

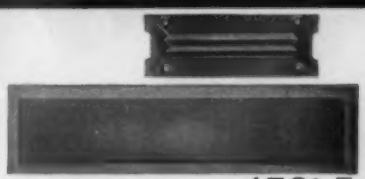
Metallized heat-reflective laminates—Improved metallizing techniques combine the reflectivity of thin, durable—603 gold or—101 aluminum coatings with high strength and thermal resistance of reinforced plastics. For prolonged heat exposure applications, blankets, compartment and valve protection, exhaust heat damping. Shown: typical compound contour part.

650° F.

Silicone laminates—Recent improvements in processing now allow the designer to take advantage of the inherent excellent strength retention under high heat and moisture. For airstream uses at missile speeds, nose and exit cones, fins, stabilizers, adapter and closure rings. Shown: missile tail cone.

600° F.

Phenolic laminates—High strength and good electrical properties at high temperatures characterize a fast increasing variety of Swedlow phenolic laminates. High dimensional stability and minimum thermal expansion make these laminates useful for nose cones, fins, stabilizers, adapter rings. Shown: molded switch cover and switch case.



450° F.

Epoxy laminates—Big improvements in electrical properties at high temperatures, together with highest strength and stability, and low moisture absorption, make the epoxies increasingly useful in design of dielectrics. For MIL-P-18177 and NEMA G-3 applications. Use for barriers, sheeting, capacitors, spacers, mountings, shielding. Shown: missile adapter block, and radome.

Swedlow: new advances in solving

HEAT RESISTANCE PROBLEMS

Improved basic heat resistant materials are only as useful as the ability to combine and fabricate them into useful parts. Swedlow research is improving that ability to an extraordinary degree. Swedlow skills embrace the above and many other advanced materials. They are available with a wide variety of filler materials, in flat sheet laminates or complex molded contours. Your difficult problems in design and producibility will be welcomed by Swedlow engineers. Send for full information, Dept. 18.

Swedlow

SWEDLOW Inc. LOS ANGELES 22, CALIFORNIA • YOUNGSTOWN 9, OHIO

For more information, turn to Reader Service card, circle No. 418

REPUBLIC PH STAINLESS STEELS

REPUBLIC A-286

In addition to excellent corrosion resistance, this precipitation hardenable grade is designed to afford elevated temperature creep and stress rupture strength to over 1200°F. Because it is used on critical applications, majority of tonnage produced is processed from ingots that have been vacuum melted by Republic's consumable electrode process. Typical applications: jet engine and gas turbine components such as wheels, blades, frames, housings, afterburners, tail cone parts, and fasteners.

REPUBLIC 17-7 PH* and PH 15-7 Mo*

These steels possess the cold formability of austenitic stainless grades . . . the hardenability of martensitic grades. High strength levels and good creep resistance are maintained at temperatures to over 700°F. and 900°F. respectively. Typical applications: aircraft and advanced missile structural parts, bellows, hose clamps, leaf springs and spring clips, pressure tanks, surgical instruments, antennae.

REPUBLIC 17-4 PH*

Simple heat treatment after fabrication develops high strength levels without excessive distortion or scaling. Unlike most martensitic chromium types, Republic 17-4 PH* is welded without preheating or post annealing, thus resulting in lower fabricating costs. Typical applications: bearings, bolts, shafts, aircraft fittings, gears, splines, mandrels, pins, seats, and valves.

BECAUSE THEY OFFER GREATER VERSATILITY, precipitation hardenable stainless steels broaden the already wide field of stainless steel applicability. Better properties at elevated temperatures are coupled with the formability and corrosion resistance of other stainless grades. Republic PH Stainless Steels are available in the standard mill products. Mail coupon for data.

REPUBLIC STEEL

Cleveland 1, Ohio

REPUBLIC HAS THE FEEL FOR MODERN STEEL

Strong, Modern, Dependable

**Licensed under Pat. Nos. 2482096, 2505763 and Trade Mark of Licensor.*

For more information, turn to Reader Service card, circle No. 380

REPUBLIC STEEL CORPORATION
DEPT.ME-2043
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Please send more information on:

☐ Republic 17-7 PH and PH 15-7 Mo
☐ Republic 17-4 PH ☐ Republic A-286

Name_____ Title_____

Firm_____

Address_____

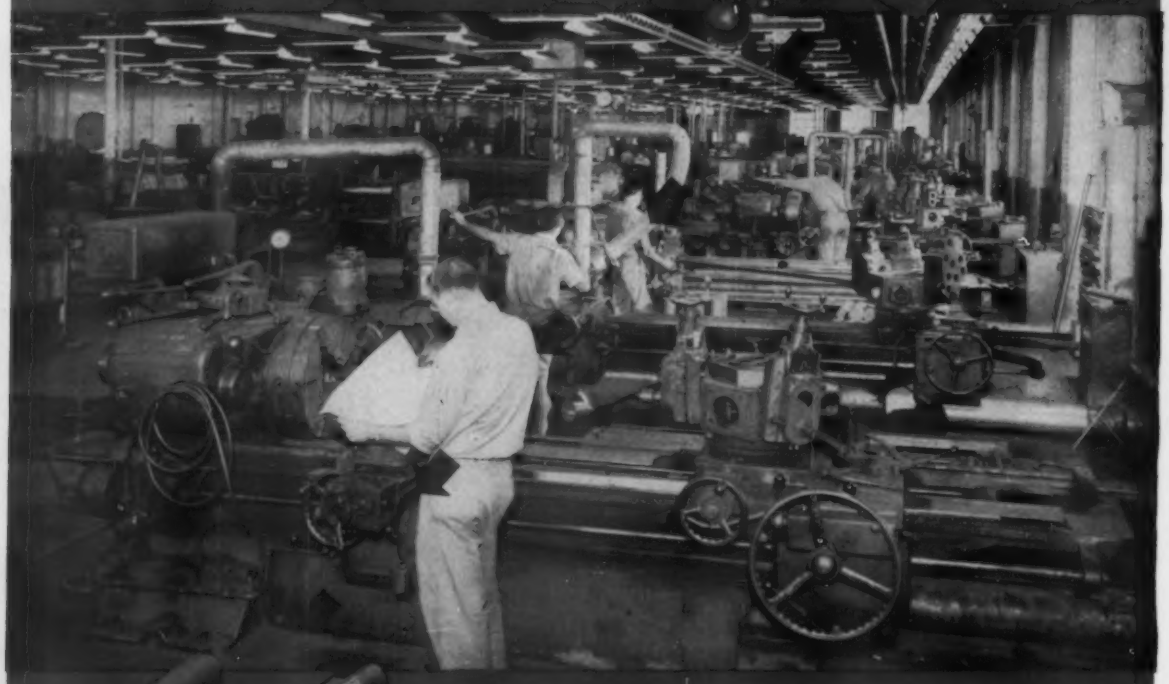
City_____ Zone____ State_____

NATIONAL GRAPHITE

TRADE MARK

is available in any size, shape and quantity!

Unmachined... *Graphite* is available from minute particles to five ton blocks... in all sizes of square, round, rectangular and cylindrical shapes. Whatever your needs—whether quantity, purity or size... made from standard or special grades—let National Carbon Company quote on your requirements.



Machined... *Graphite* is machined economically at National Carbon Company because we have years of experience handling this unique material plus several strategically located, modern machine shops. For simple or complex shapes . . . large or small pieces . . . intricate details with close tolerances . . . let National Carbon Company quote the job. For data, contact our representative or the nearest sales office.

"National" and "Union Carbide" are registered trade-marks for products of

NATIONAL CARBON COMPANY

Division of Union Carbide Corporation • 270 Park Avenue, New York 17, New York

IN CANADA: Union Carbide Canada Limited, Toronto

UNION CARBIDE

For more information, turn to Reader Service card, circle No. 484

Mr. Design Engineer:
Is high torque strength of interest to you?

Take a look at the reinforced Plaskon® Nylon specified by a prominent manufacturer for their newest outboard propeller. The material is Nylafil G-3 — Plaskon Nylon reinforced with glass fibers under carefully controlled conditions by the Fiberfil Corporation, Warsaw, Indiana.

They chose this material because of its outstanding tensile and flexural strength which enables it to meet the high torque requirements of an outboard propeller. Also important are its excellent resistance to corrosion and electrolysis, outstanding impact resistance, light weight, improved dimensional stability, and fine resistance to abrasion (propellers are tested by running over sand bars and oyster beds).

Even if your field isn't marine engineering, these properties should be of interest to your particular design problem. Let our Applications Engineering Group work with you — write our Nylon Design Department.

PLASTICS DIVISION
40 Rector Street, New York 6, N. Y.

Allied Chemical
BASIC TO AMERICA'S PROGRESS

For more information, turn to Reader Service card, circle No. 490

Take a lead from the leaders...

Since 1948, Amchem ALODINE* treated over 1½ Billion square feet

Popular Reynolds Colorweld pre-finished aluminum panels find wide application in commercial construction where its enduring performance and good looks are helping to change the architectural face of industry. Alodine contributes its protective qualities to Colorweld's amazing paint performance.

Conversion Coating Chemicals have of Aluminum in Reynolds Plants!

From 1955, when Reynolds Colorweld** Production was started, Reynolds has used ALODINE; Continue to Report Complete Customer Satisfaction with Paint Adhesion on this Quality Pre-Enameled Aluminum Product

At two Reynolds producing facilities—Atlanta, Ga. and McCook, Ill.—Alodine chemicals used in the pre-paint treatment of Colorweld offer a typical example of Reynolds' continuing emphasis on product quality.

Each day at these plants thousands of feet of aluminum are treated with Alodine to provide the metal with a chemical coating which produces high quality paint bonding characteristics so essential to the durable Colorweld finish Reynolds demands.

Alodine provided the first economical treatment that made possible the mechanical forming of pre-painted aluminum. Under extremely high volume processing speeds, the outstanding attributes of Alodine benefit aluminum products of all types—through improved paint bonding for subsequent mechanical forming operations, that means extra years of wear for painted aluminum under all types of environmental conditions.

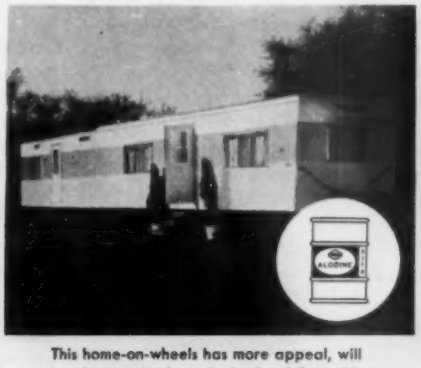
Behind the success of Alodine as the outstanding pre-paint treatment for aluminum stand the research and development activities of Amchem's Metal Protection Laboratories where the search continues for even more efficient aluminum treating chemicals.

Take a lead from the leaders. If you're producing aluminum—bare or coated—specify Alodine for the assured quality and added beauty of your finished product.

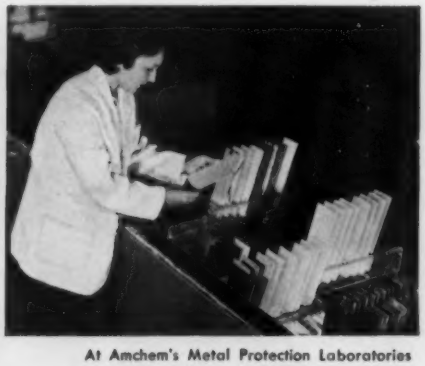
*Amchem's registered trademark for its conversion coating chemical for aluminum.

**Colorweld is a registered trademark of the Reynolds Metals Company.

Beauty and durability characterize siding of Reynolds Aluminum Colorweld for home use. Alodine chemicals help provide a paint bond that lasts and lasts.



This home-on-wheels has more appeal, will last longer thanks to its body of Reynolds Aluminum Colorweld, and a firm paint bond thanks to Alodine.



At Amchem's Metal Protection Laboratories exhaustive quality control testing assures the performance of Alodine chemicals for every aluminum pre-paint requirement.

AMCHEM **ALODINE**

Write for Bulletin 1424C, gives detailed technical specifications on different Alodine chemicals available for pre-treating aluminum.

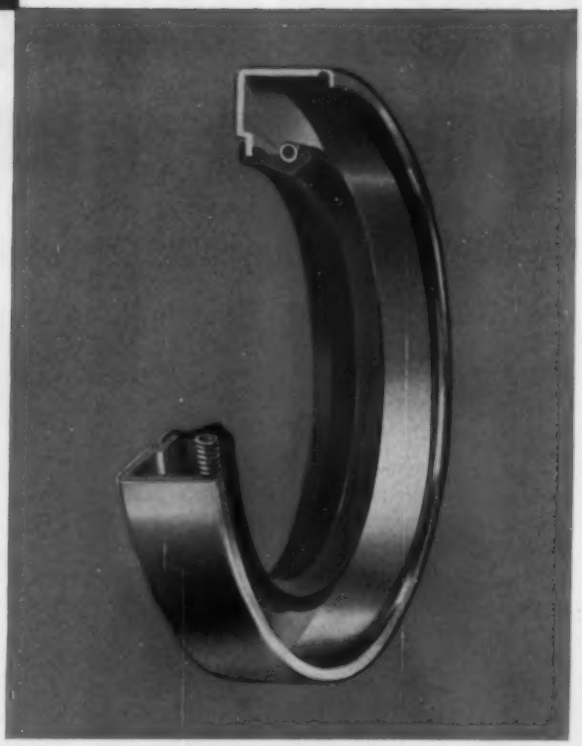
Amchem is a registered trademark of
AMCHEM PRODUCTS, INC. (Formerly American Chemical Paint Co.)
AMBLER, PA. • St. Joseph, Mo. • Detroit, Mich. • Niles, Calif. • Windsor, Ont.

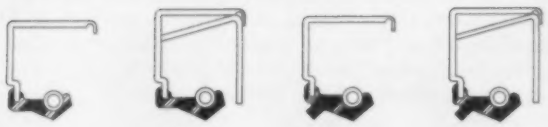
For more information, turn to Reader Service card, circle No. 485

C/R®

DESIGN NOTES

C/R offers new bonded CRS Seal design in standard sizes — without premium tooling charges





Design Advantages

The CRS Seal now provides a new level of C/R Seal performance through its simple, bonded design. There are no internal parts to misalign, no avenues for internal leakage. The shell and sealing member are integral — bonded securely for the long life of the seal. The CRS Seal incorporates a sealing member with both improved lip configuration and improved concentricity. The sealing member has been strengthened over former designs by placing more material at points of major flex and wear — and without increased shaft loading.

Designer Advantages

The CRS Seal gives the designer one, basic, rugged shaft seal design which may be applied with high reliability to the great majority of common shaft seal applications — particularly in industrial, automotive, farm, and off-the-road equipment.

Four basic design variations are available. As you can see, these provide an auxiliary sealing lip, where it may be required, or provide extra rugged shell construction where conditions suggest the need to protect the seal lip against assembly damage — or where large, heavy-duty shafts are being sealed.

Selection of the new C/R Type CRS Seal gives the designer and buyer major advantages over special seals: shorter lead time on orders, simpler specification, savings in time and money, and improved assembly quality and reliability.

Operating Maximums*

Shaft Speeds	3600 fpm (single lip) 2500 fpm (double lip)
Run-out	.016" TIR dynamic eccentricity .010" static eccentricity
Temperature	−30 to +275°F. (225°F. in EP lube)
Pressure	5 psi (single lip) 10 psi (double lip)
Media	Oil, grease, fuel, water

Not all conditions present in one application

New, Improved Compound

Standard sealing members for the C/R Type CRS Seal are molded of a new Sirvene synthetic rubber compound having markedly superior sealing and wearing properties. It is a Buna-N-based material with low-friction characteristics. The CRS Seal can also be furnished in the usual special materials such as acrylates, Silicones, and butyls. Shells are of standard steel, but can be provided in corrosion-resistant materials on special order.

Consult C/R Engineers

For assistance on the application of the new CRS — or on any oil seal problem, get in touch with C/R Oil Seal Engineers. They're specialists in fluid sealing — and will gladly cooperate with you.

For More Design Data:

You will want the complete design data on the new CRS Seal. Write for our Bulletin CRS-100. It gives you the complete list of standard sizes, widths, O.D.'s, shell thicknesses and sealing lip heights. You will want it to compare and then specify C/R's CRS Seal.

CHICAGO RAWHIDE MANUFACTURING COMPANY

1227 Elston Avenue • Chicago 22, Illinois

Offices in principal cities

See your telephone directory

In Canada: Chicago Rawhide Mfg. Co. of Canada, Ltd., Brantford, Ontario

Export Sales: Geon International Corp., Great Neck, New York

For more information, turn to Reader Service card, circle No. 509

SANDVIK 11R51 STAINLESS STEEL

A Proven Solution To These Spring Problems

Sandvik 11R51 steels' combination of high corrosion resistance and superior spring characteristics has proven itself in spring designs which must.....

1. Withstand severe temperature changes and condensates
2. Have high fatigue life and tensile strength
3. Provide high torque values
4. Not creep during long period of stress
5. Give consistent, predictable results

To learn more about how this special steel can solve your specific spring design problems, eliminate the need for redesign and retooling, and improve your product, *use this coupon.*

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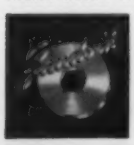

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Works: Sandviken, Sweden.

88-326

SANDVIK STEEL, INC.
1702 NEVINS RD., FAIRLAWN, N. J.

☐ Please send me your free booklet on Sandvik 11R51.
☐ Please have your representative phone for an appointment.

Name_____ Title_____

Company_____

Address_____

For more information, turn to Reader Service card, circle No. 327

Which of these forms do you need?

The photograph at the right illustrates the large number of forms in which FIBERFRAX, the most versatile ceramic insulating material, is now available. The variety of these forms offers wide scope for application in almost any product design or manufacturing operation involving high temperature insulation problems. They present a unique challenge to the design engineer seeking new materials for profitable exploitation.

FIBERFRAX®
CERAMIC FIBER

A versatile, high temperature insulating material

FIBERFRAX is a strong, fluffy, light weight alumina-silica fiber produced by subjecting molten alumina and silica to the action of high velocity gases. It will not melt below 3200°F and can be used continuously at temperatures up to 2300°F. It has extremely low thermal conductivity, high thermal shock resistance, and excellent chemical stability. It can be used as a high temperature insulator, a light weight refractory, or a filter.

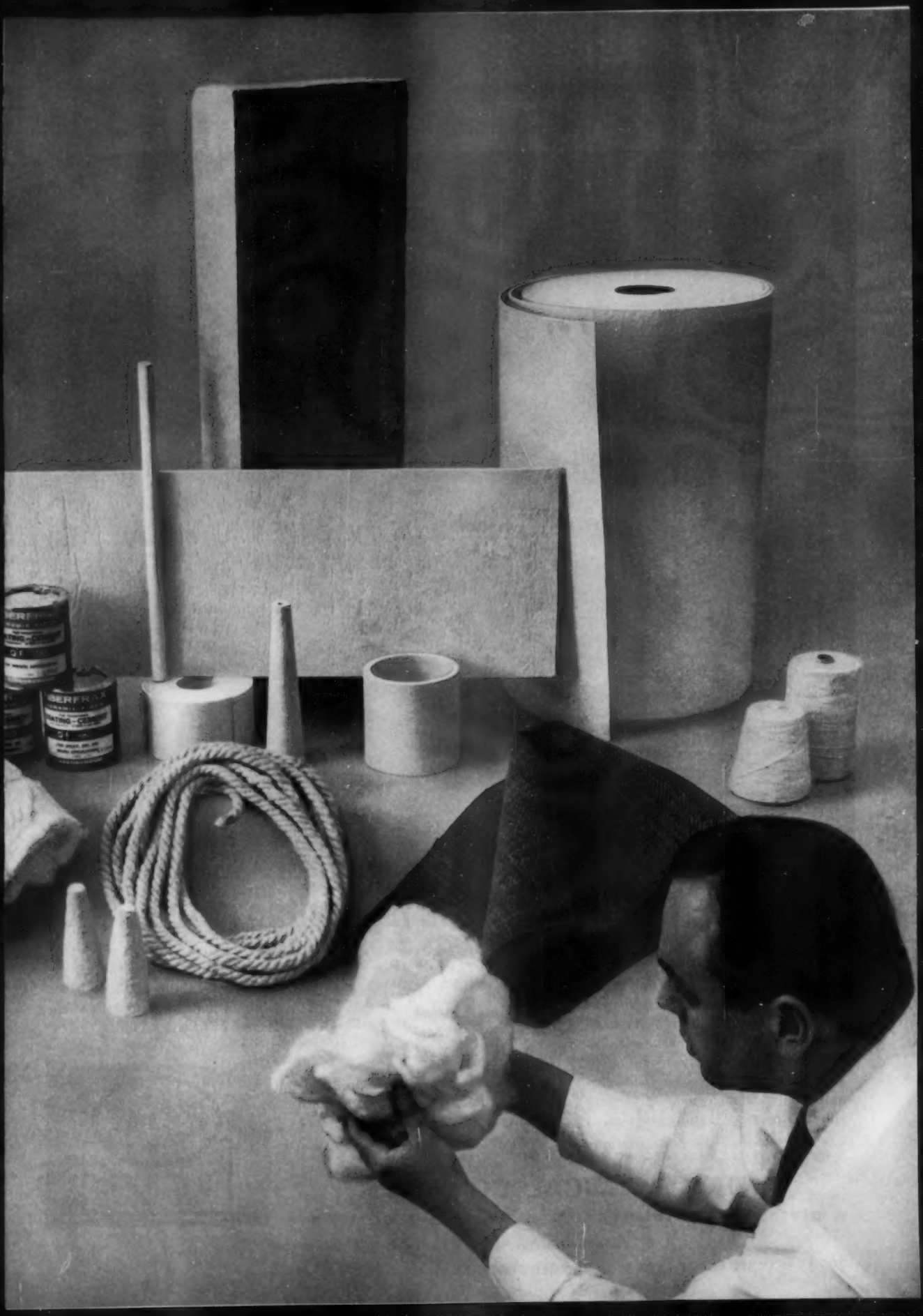
FORMS AVAILABLE: These include the basic bulk fibers, which are processed into chopped fiber, roving, yarn, rope, cloth, tape, paper, board, block, blanket, tubing, castable and formed shapes. In addition, an air-setting coating-cement is offered for trowel, spray, dip or brush application.

WIDE RANGE OF APPLICATIONS: A typical, highly successful application of FIBERFRAX is in lining the combustion chambers of domestic oil fired furnaces, in which a ⅛" thick FIBERFRAX paper replaces brittle, bulky refractories. Other applications include linings and insulation for industrial furnaces and kilns, acoustical and thermal insulation for jet engine test cells, covering for high temperature electric cable, filters for high temperature gases, and a wide variety of packings and gaskets.

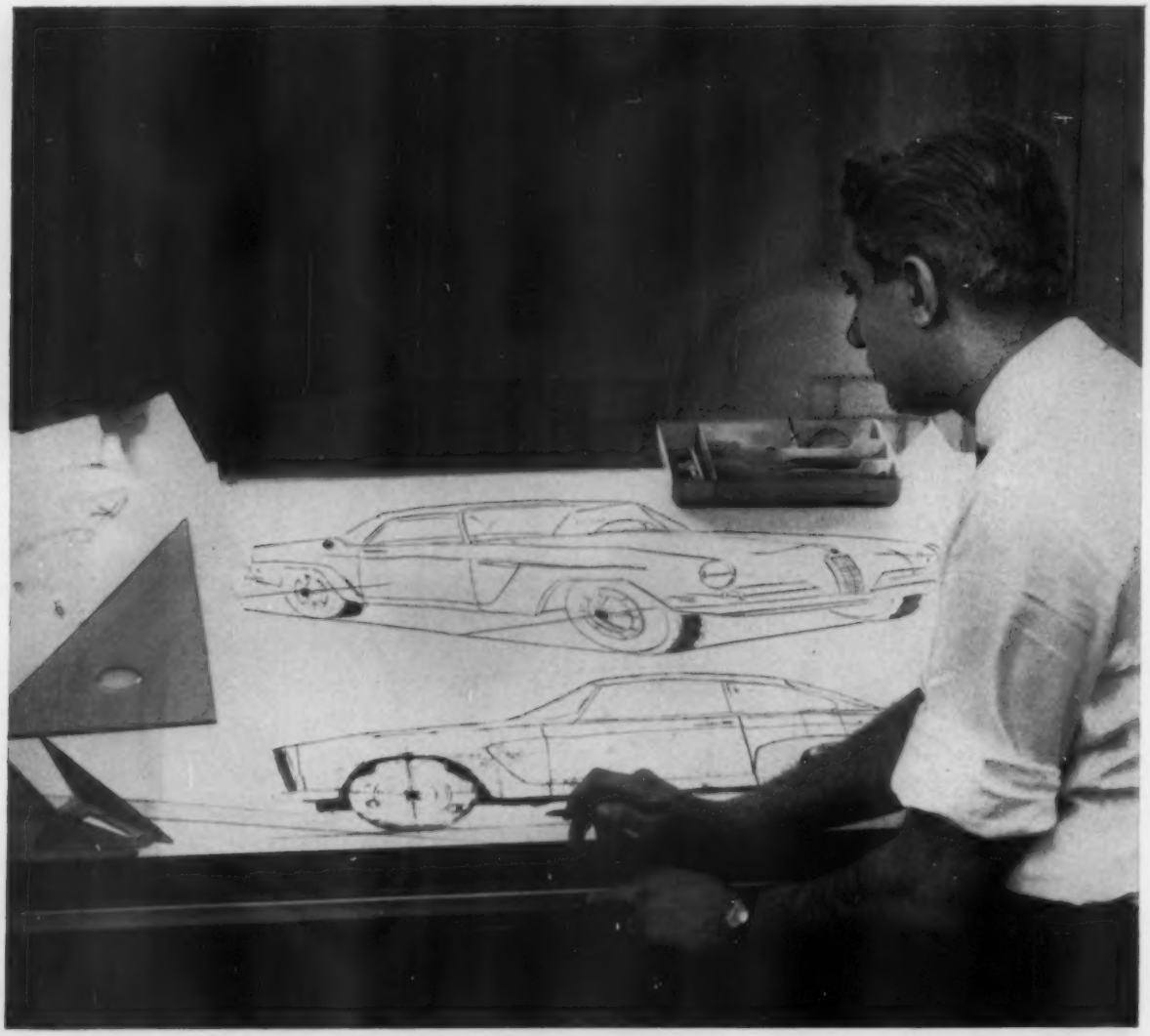
A NEW FIBERFRAX BULLETIN is now available. This bulletin presents technical data on the properties of the material and suggests potential applications. For your copy, write Dept. MD-71, Ceramic Fiber Project, Refractories Division, The Carborundum Company, Niagara Falls, N.Y.

CARBORUNDUM®

For more information, circle No. 500



WHAT'S NEWS IN RUBBER



In design after design...the big switch is to BUTYL!

Automotive engineers have discovered that Enjay Butyl rubber is one of the best ways to improve car performance. Now all U.S. cars contain parts made from Enjay Butyl . . . parts such as weatherstripping, body mounts, engine mounts, radiator hose, accelerator pedals, and many more. Engineers specify Enjay Butyl rubber because...

- *Butyl resists weathering*
- *Butyl deadens noise and vibration*
- *Butyl absorbs shock*
- *Butyl beats the heat*
- *Butyl resists tear, flex and abrasion*

Enjay is always ready to help manufacturers build the extra performance of Butyl into their cars. For more information, contact Enjay's Detroit Area Office, 17360 West Eight Mile Road, Southfield, Mich. Phone KEnwood 2-7113.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

ENJAY® BUTYL

For more information, turn to Reader Service card, circle No. 468

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

A Philadelphia Extruder Reports:

"DIES MADE FROM CROMO-WV DISCS WEAR WELL AT HIGH TEMPERATURES"

In the busy extrusion plant of Michael Flynn Manufacturing Co., Philadelphia, they're getting outstanding service from extrusion dies of Bethlehem Cromo-WV upset-forged discs. The dies, which extrude a variety of aluminum sections, are hardened to Rockwell C47-50. They are particularly impressive because of their long service, and their ability to withstand high-temperature operations.

Cromo-WV (H-12) is ideal for extrusions tooling because of its 5 pct chrome content and balanced analysis which give it high resistance to heat checking. And it has excellent red hardness, plus the ability to withstand shock and wear.

You're sure to like the economy and long service of dies made from Cromo-WV upset-forged discs. Place your order today with your Bethlehem tool steel distributor.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Here's the Way to Grind Tools

After tools are hardened, it is customary to grind them to remove scale and decarburization, or to produce exact dimensions, or both. Basically, the aims are: removal of the desired amount of metal without damaging the hardened surfaces, and the most rapid development of the required surface finish.

It is usually recommended that hardened tools be ground with a vitrified aluminum oxide wheel of 24 to 80 grit. For example, a coarse grit, such as 24, should be used on Bethlehem Lehigh H . . . a high-carbon, high-chrome grade (D-2). The finer grits can be used on Cromo-WV hot-work grade (H-12). The use of soft wheels is suggested. Effective cooling should be done at the point of wheel contact, by using adequate cooling fluid. About .002 to .003 in. should be removed per pass for roughing cuts, and .0005 in. per pass (or less) for finishing cuts.

Hand-stone or fiber-wheel brush the tool edges after grinding, to remove burrs. In many shops, these operations have been replaced by a finish grinding pass with a 320-grit wheel. Properly applied, this pass leaves no burr.

For more information, turn to Reader Service card, circle No. 412

...LET TROYFELT CLEAR THE AIR!

If you're looking for a filter material that will outperform any you've used before, you owe it to yourself to test Troyfelt.

Troyfelt is a *non-woven* synthetic felt—the fibers are mechanically interlocked. This eliminates the need for chemical or mechanical binders within the felt—those troublesome elements that are the principal cause of "blinding".

Moreover, Troyfelt is a synthetic—available in Dacron, Orlon or blends. As such, it offers users outstanding abrasion, heat and chemical resistance properties.

But most important: we can match *your* needs precisely. We can give exactly the weight, density, thickness, permeability and strength you want. Tell us your problem and we'll "Tailor" Troyfelt to do the job. Meanwhile, send for samples and our latest brochure.

TROYFELT—MATERIAL OF A HUNDRED AND ONE USES
- vibration dampening • gasketing • seals • polishing
- insulating . . . wherever felt's a factor, test Troyfelt

TROYFELT... by the pioneers in non-woven synthetic felts

INDUSTRIAL PRODUCTS DIVISION · TROY MILLS, INC.
200 MADISON AVENUE · NEW YORK 16, NEW YORK

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if she takes pride
in her home—
give her a kitchen
of stainless steel
McLOUTH
STAINLESS
STEEL—the spotless
metal for homes and
home products.
McLouth Steel Corporation
Detroit 17, Michigan

How wood engineering helps improve skiers in July

THE "BONGO BOARD" (above) is an exercise and balancing device which, among many other recreational uses, is popular with skiers as an off-season training aid.

When Bongo Corporation came to Gamble Brothers, seven years ago, they needed a supplier who could produce platforms and rollers which would retain dimensional stability despite repeated twisting and hard pounding; which would not scuff carpets or damage floors when used inside; which would operate smoothly and quietly; and which could be produced at low unit cost. Gamble Brothers' facilities and experience "filled the bill" then, and still do now.

Problems like this are "all in a day's work" to the wood engineers at Gamble Brothers—a unique organization designing and building a wider variety of wood products than any other U. S. woodworking company. Today they're working in three principal areas: (1) improvement of present wood products (2) development of new wood products (3) product development in combinations of wood and other materials.

Why not present *your* design problem to Gamble Brothers? WOOD may be the answer!

FREE booklet illustrates GAMBLE services

This 28-page booklet describes Gamble facilities and services in detail. Includes many photographs of unusual products designed, tested and perfected by Gamble Brothers. Write for your copy today! Gamble Brothers, Inc., 4627 Allmond Ave., Louisville, Ky.

If the problem involves wood, Gamble can help!

GAMBLE BROTHERS, INC.

4627 Allmond Avenue, Louisville, Kentucky

For more information, turn to Reader Service card, circle No. 402

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READY

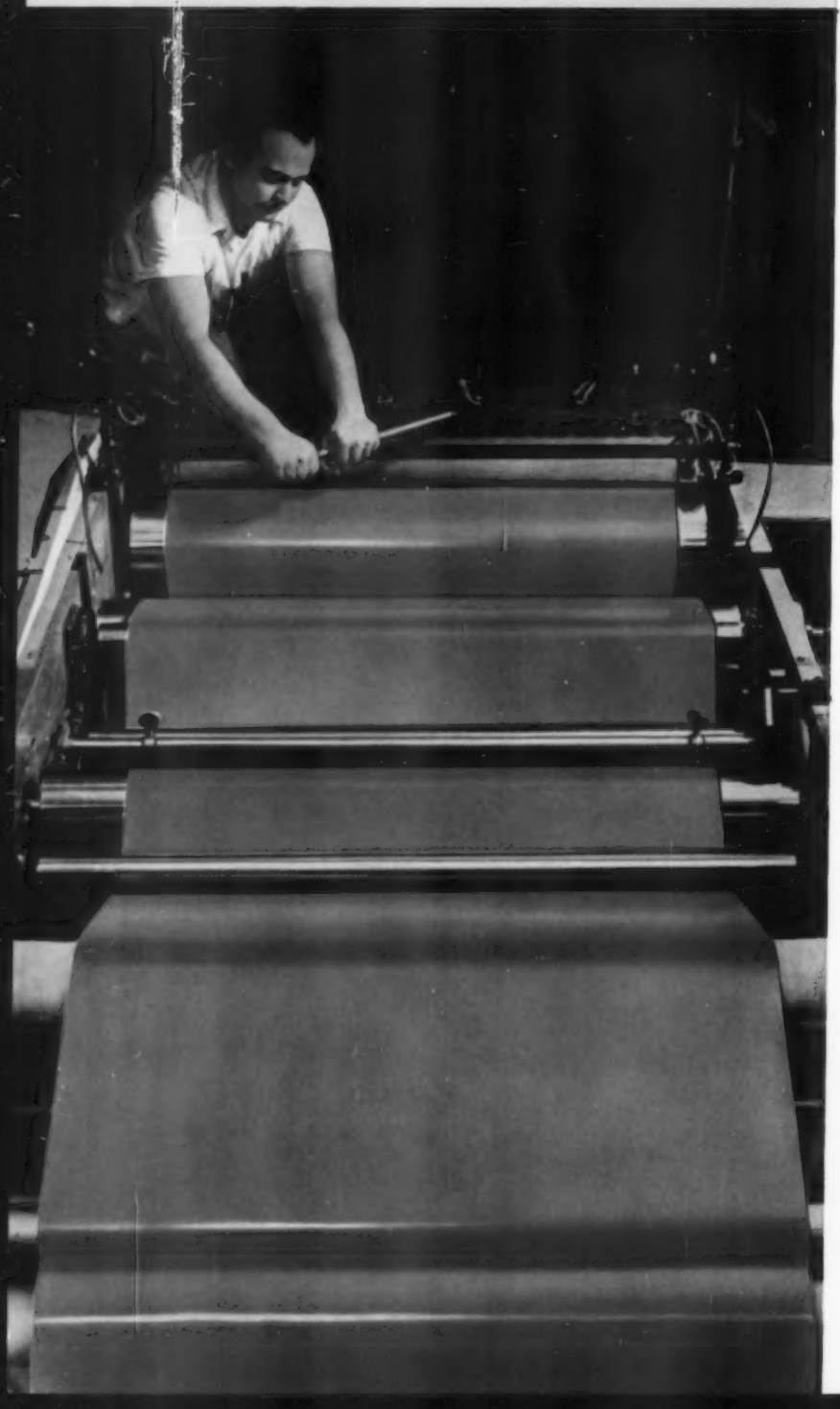
...to help you plan new products
...to help you improve existing products
...to help you cut manufacturing costs

Since February, 1961, Tenite Polypropylene has been in commercial production at Eastman's new plant in Longview, Texas. This is the newest member of the Eastman family of thermoplastics, all bearing the trade name "Tenite."

In Tenite Polypropylene, industry has a versatile new plastic that will replace conventional materials in many traditional applications . . . a plastic that will improve the performance of hundreds of existing products . . . a plastic that could markedly reduce material, fabricating and assembly costs.

And it's a material that's now available in carload quantities.

Tenite Polypropylene offers a broad range of useful properties



High Strength – Tenite Polypropylene has good tensile and impact strength, plus rigidity and surface hardness.

Light Weight – Tenite Polypropylene is the lightest of all solid plastics. This plastic produces more molded or extruded product per pound than most other plastics.

Heat Resistance – The high melting point of Tenite Polypropylene permits objects made from this plastic to be sterilized without suffering distortion. This feature makes it well-suited for hospital and laboratory ware.

Chemical Resistance – Tenite Polypropylene resists the attack of acids and alkalies and a broad range of other chemicals.

Fatigue Resistance – Because it can take innumerable flexings, Tenite Polypropylene can be designed as one-piece moldings with integral hinges.

Resistance to Moisture Vapor Transmission – Tenite Polypropylene is an effective barrier to moisture vapor transmission. In film for packaging, this feature is a vital factor in prolonging the freshness of many foods.

Red polypropylene sheet rolls off an extruding machine in Eastman's plastics development laboratory. For two full years before launching polypropylene production on a full-scale commercial basis, Eastman engaged in exhaustive research and study of the characteristics and properties of polypropylene, thoroughly pretesting the material in actual molding and extrusion operations and developing a number of formulations for use in plastics fabrication.

Tenite Polypropylene can be used in all these ways

Dielectric Strength – Tenite Polypropylene has excellent dielectric properties and retains these properties even under adverse moisture and temperature conditions.

Abrasion Resistance – Tenite Polypropylene has excellent abrasion resistance. Its surface hardness suggests its use as gears or bearings. Conveniently, it also has a low coefficient of friction.

Resistance to Environmental Stress Cracking – Tenite Polypropylene has excellent resistance to stress cracking. No environment has yet been discovered in which stress cracking of polypropylene occurs.

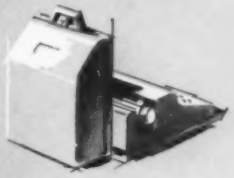
High Gloss – Articles molded of Tenite Polypropylene have a natural lustrous finish, and film extruded of Tenite Polypropylene exhibits a sparkling surface.

Heat Sealability – Tenite Polypropylene is relatively easy to "tack" or "weld." This can be accomplished in many cases with existing equipment.

Printability—With a simple treatment, film of Tenite Polypropylene can be easily printed by conventional methods.

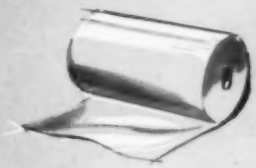
Resistance to Mold and Mildew—Tenite Polypropylene resists the growth of mold or mildew, and is not attacked by insects or marine organisms.

Processability—Tenite Polypropylene has excellent flow properties, permitting good mold-fill in injection molding.



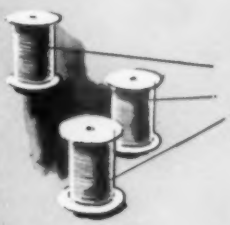
Injection Molding

Tenite Polypropylene can easily be molded into a wide variety of durable low-cost parts with high gloss and surface hardness—for example, appliance housings, automotive accessories, toys and housewares.



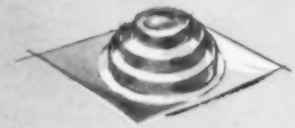
Extruded Film and Sheeting

Tenite Polypropylene can be extruded into sparkling clear film and sheeting, with the excellent protective characteristics so important for durable packaging. It can also be extruded in opaque, translucent, or transparent colors.



Monofilament

Tenite Polypropylene can be extruded into monofilament offering high strength, wet or dry, and excellent flexibility at low temperatures. Webbing for outdoor furniture and cordage are among the many possible end uses for this tough material.



Thermoforming

Sheet of Tenite Polypropylene can be used in vacuum forming, pressure forming and skin packaging, with existing equipment.

Wire and Cable Covering

Excellent electrical, thermal, and mechanical characteristics make Tenite Polypropylene desirable for either primary insulation or jacketing. Formulas are available for solid coatings, or for cellular coatings of extra-low dielectric constant.

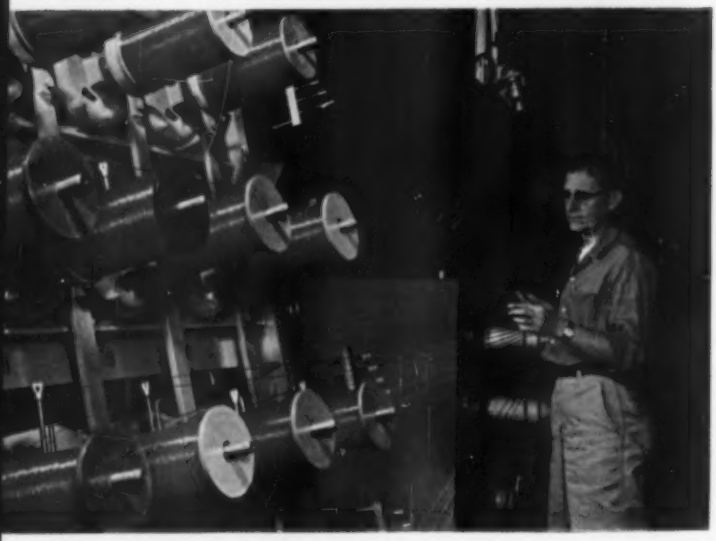
Pipe

Chemical inertness, resistance to stress cracking, and heat resistance make pipe of Tenite Polypropylene a good choice for industrial use.

Blow Molding

Tenite Polypropylene in special formulations can be blow-molded into many articles possessing exceptional wall strength, resilience, and chemical resistance.

Spools of lustrous red polypropylene filament, extruded for testing purposes in Eastman's development laboratories. Eastman's work over many years in producing plastics of almost unlimited colors has been of significant value in developing superior polypropylene formulations for monofilament extrusion.



A special word about this new polypropylene

The process for manufacturing Tenite Polypropylene was developed by Eastman scientists, engineers and production staff. This exclusive process yields a polypropylene that is superior in several characteristics to other polypropylenes. We base this statement not only on our own laboratory findings but on the opinions expressed by those users who have had the opportunity to evaluate Tenite Polypropylene from our semicommercial plant during the past year.

Since the first Tenite plastic was produced, in 1932, over 42,000 color effects have been formulated in the Tenite color laboratory. This experience, plus pre-eminence in color photography and textile dye technology, enables Eastman to offer the broadest range of colors available in the entire plastics industry. We believe that Tenite Polypropylene represents an improvement in quality and stability of color in this type of plastic. And Tenite Polypropylene color concentrates now offer molders and extruders a clean, easy way to color polypropylene. Use of these concentrates virtually eliminates color contamination and color uncertainty.

We have given you only the highlights on this promising new plastic. For further information, call a Tenite sales office or send this coupon to EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

EASTMAN CHEMICAL PRODUCTS, INC.
subsidiary of Eastman Kodak Company, Kingsport, Tennessee

Please send me more information on Tenite Polypropylene,

for _____
(product or purpose)

Name _____ Title _____

Company _____

Street _____

City & State _____ Tel. _____

This glimpse into the color chip storage room at the Tenite Color Laboratory gives some indication of the variety of colors that has been developed by Eastman since 1932.

Measuring the optical properties of Tenite plastics is but one phase of the diverse and thorough testing done in the Tenite Quality Control Laboratory.

Eastman technical service representatives are ready to work with any customer in finding the most efficient way in which to fabricate products of Tenite Polypropylene.

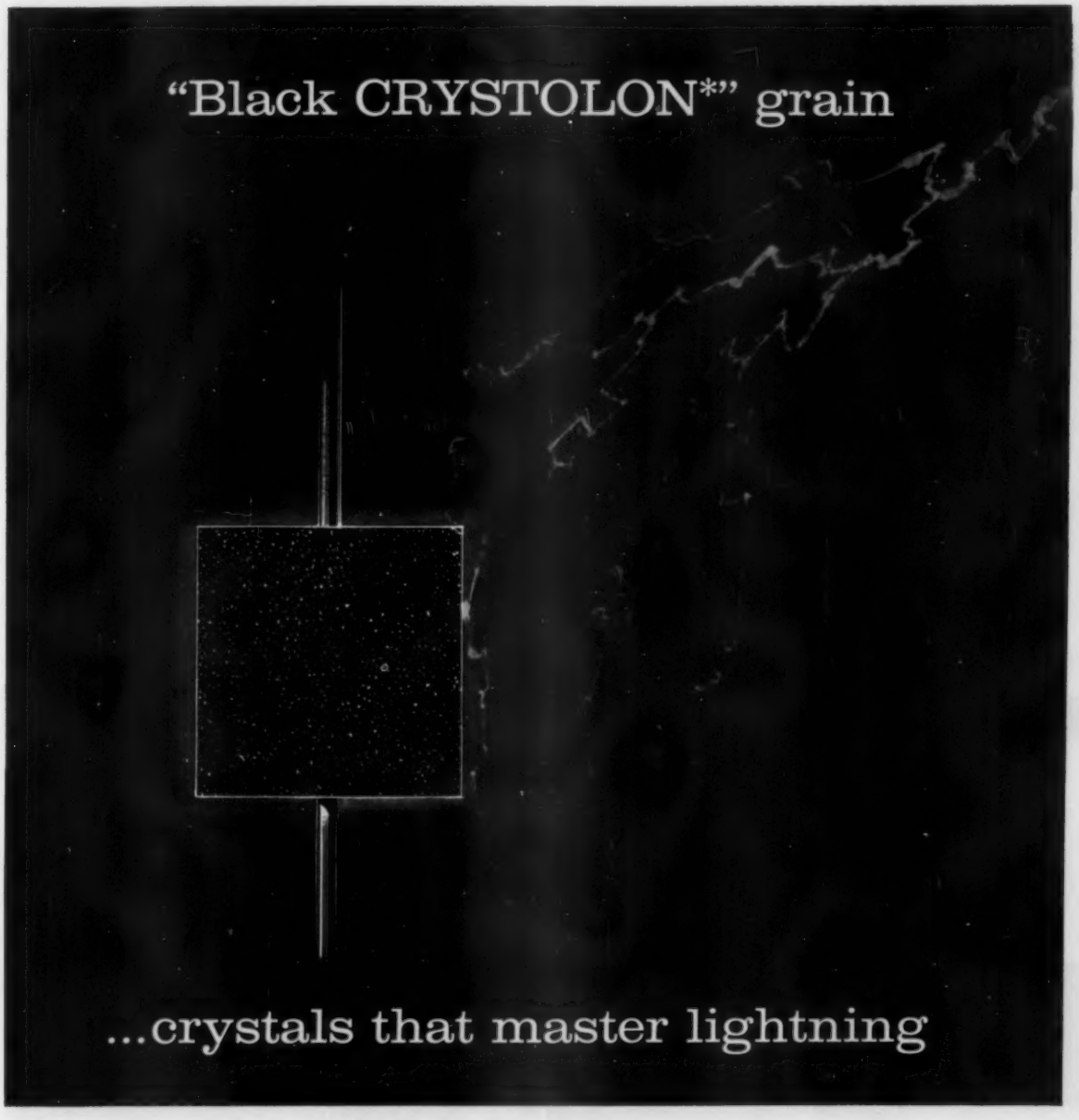
TENITE®

POLYPROPYLENE

an Eastman plastic

Other plastics made by Eastman include Tenite Polyethylene, Tenite Butyrate, Tenite Propionate, Tenite Acetate, and Tenite Polyester. Information on any of these materials is also available on request.

Printed in U.S.A.



Often referred to as "Black CRYSTOLON", Norton E 179 CRYSTOLON Electrical Grade silicon carbide grain is widely used in lightning arrestors — and in a steadily increasing variety of other nonlinear resistor applications in the electrical-electronics field.

These applications include protection of coils from overvoltage, protection of relay contacts, and general voltage stabilization . . . with voltage or surge control requirements ranging from thousands of amps to microamps . . . in resistors ranging in volume from thick arrestor blocks to paper-thin varistors.

To control its semiconduction properties, E 179 differs from regular CRYSTOLON silicon carbide grain by the addition of alumina. But the most important control of E 179 is constant control through each step of manufacture, from electric furnace to shipping drum. Accurate, duplicable grain impedance (resistivity) is assured by careful furnacing, grain processing, sizing, blending and surge testing.

In loose pack or ceramic bonded form, E 179 CRYSTOLON grain has the nonlinear current-voltage relation $I = AE^n$, where "A" and "n" are constants. For loose grain "n" may be as high as 10; for bonded grain it is usually between 3 and 7.

For surge tests, standard 280 ampere pulses are passed through a column of compressed E 179 CRYSTOLON grain, 1" diameter x 1" long. Voltage across the cell is measured in kilovolts per inch. E 179 CRYSTOLON grain is available in sizes of 60 to 240 mesh, covering a surge test range of 1.6 to 13.0 KV/inch.

For further facts, contact NORTON COMPANY, Refractories Division, 344 New Bond Street, Worcester, Mass.

*Trade Mark Reg. U. S. Pat. Off. and Foreign Countries.

NORTON
REFRACTORIES
Crystallizing ideas into products

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GRAPHITAR®

(CARBON-GRAPHITE)

FOR DEPENDABILITY

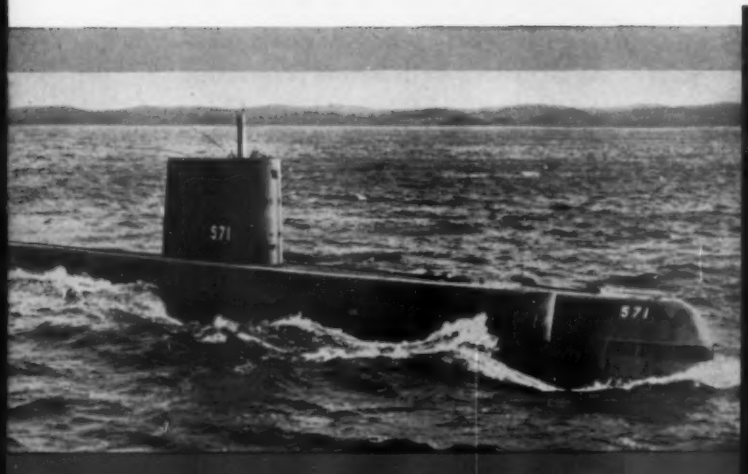
GRAPHITAR'S own character makes it dependable. A non-metallic engineering material, formed from carbon and graphite powders and a special binder, compacted under high pressures and furnaced at temperatures up to 4,500°F., GRAPHITAR possesses inherent characteristics that give finished parts exceptional dependability. GRAPHITAR'S natural heat resistance, for example, gives bearings, seals, vanes and rings exceptional dependability whenever dependability is one of the prime requisites.

There are other characteristics every bit as important to GRAPHITAR'S dependability. They include chemical and magnetic inertness, mechanical strength and adaptability to self-lubrication. Besides these natural characteristics, GRAPHITAR engineers can control porosity, strength and hardness to match GRAPHITAR'S physical properties to each individual application. It's little wonder that GRAPHITAR has become one of the design engineer's most versatile and useful materials.

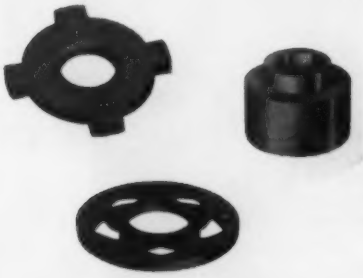
In this laboratory test stand, oxidation-resistant GRAPHITAR parts are being checked under simulated operating conditions. Similar tests have proven that, when GRAPHITAR parts are exposed in oxidizing atmospheres at 1,200°F., they show only a weight loss of less than six percent after 200 hours.

In the Engineering Department of The United States Graphite Company, micro-photo studies are indispensable in the study of internal part structure. The Metallograph is just one of dozens of modern technological aids employed in both the quality control of production GRAPHITAR parts and in the research and development of new products. GRAPHITAR parts are engineered for dependability.

GRAPHITAR air/oil seals employed in today's high-speed turbojet engines have established an enviable record for operating dependability. Installed on the main shaft of the turbine, GRAPHITAR seals successfully withstand tremendous shaft speeds and generated heat.



GRAPHITAR bearings in the power reactor pumps of American nuclear submarines have compiled an outstanding record for dependability.



Unusually shaped parts of GRAPHITAR can be molded easily with today's modern techniques. Ears, face slots and outside diameter notches of friction disc above, left, were molded in one operation without need for secondary machining and finishing.

Do you have an application in which GRAPHITAR'S dependability can help solve a tough problem, reduce your costs and improve the operational life of your products? Our engineering staff can help you find out. Our field men can also give specialized, on-the-job consultation. Send for your free copy of Engineering Bulletin #20. Included is helpful information about the properties, characteristics and applications of GRAPHITAR.

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 3, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

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R-294-2

are you being ROBBED by finishing REJECTS?

Even the most expensive materials and the finest finishing processes can produce costly rejects if "bargain" compounds have failed to do their job. A finish can be no better than its surface preparation.

Northwest's Cleaning Specialists offer a complete line of top quality products for every "surface readying" requirement, on every type of material. These products have *proved* their dependability over years of rugged production use in the country's finest finishing operations.

Northwest's continuing research and development program keeps our products well ahead of industry's constantly changing requirements. Our fine staff of thoroughly experienced Cleaning Specialists will gladly help you work out the best surface preparation for your product and "stand by" to help you keep it functioning at top efficiency.

Why not save time and rejects by using Northwest's dependable products and services.

Licensed Manufacturers: | Alert Supply Co., Los Angeles, California
Armalite Company, Ltd., Toronto, Canada

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CHEMICAL PRODUCTS DIVISION • CHEMETRON CORPORATION

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"HOT" DESIGN PROBLEMS?

Call on PB&B high conductivity copper

Designing for temperatures which would melt most metals and would even be tough on refractories? Investigate the possibilities of PB&B high conductivity copper—a versatile material that lives in heat because it's so easy to keep cool.

For example, PB&B high conductivity copper is being used successfully in water cooled crucibles for refining exotic metals . . . in bosh plates and tuyeres for blast furnaces . . . and in oxygen lance jet heads for open hearths.

And it is excellent for electronic equipment, too. Oxygen-free, highest purity grades are immune to hydrogen embrittlement, and thus ideal in high-vacuum tubes.

We have nearly 40 years' experience in making non-ferrous forgings and castings. Special PB&B techniques for casting copper cooling tubes in place in copper castings† provide maximum heat transfer. We use only certified highest conductivity materials, to assure you of the performance you need for high temperature service.

For forgings: OFHC* COPPER—oxygen-free, 99.99+% pure copper, guaranteed minimum 98% IACS conductivity; and related alloys such as AMSULF*—a sulfur-bearing alloy of OFHC copper, with high machinability, ductility and working properties; and AMZIRC*—zirconium-OFHC copper alloy having high strength at elevated temperatures. We're a recommended source for forgings of these American Metal Climax products.

For castings: We use virgin electrolytic copper and a special deoxidizing process to assure a minimum conductivity of 90% IACS.

Fill in and mail the coupon below, or ask for personal consultation on your specific problems.

†*Patent applied for*
**Registered trade-mark—American Metal Climax, Inc.*

PHILADELPHIA BRONZE & BRASS CORP.
22nd and Master Streets, Philadelphia 21, Pa.

Non-ferrous forgings, castings and fabrications

a subsidiary of P. R. MALLORY & CO. Inc. MALLORY

PHILADELPHIA BRONZE & BRASS CORP.
22nd and Master Streets, Philadelphia 21, Pa.
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☐ High conductivity copper forgings
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IPC adds service time to your end product with "RULON"...*

the tested... filled fluorocarbon material for packings and oil seals

IPC now incorporates "RULON"* . . . a *filled fluorocarbon plastic material* . . . in packings, oil seals or precision molded products to answer your most critical sealing problems.

This new combination . . . "custom" molded and bonded for your specific application offers many advantages: Superior abrasion resistance, lower friction, improved sealing, less torque and reduced shaft wear.

Special molding and bonding techniques, developed by IPC for "RULON"* insure long wear and excellent performance. For your critical applications investigate the extras of IPC's latest "custom" approach! You'll find more benefits in handling increased pressures . . . higher shaft speeds . . . and temperature problems too!

**Trade Name of Dixon Corporation.*

IPC

OIL SEALS / PACKINGS / PRECISION MOLDING *Custom designed for your application.*

INTERNATIONAL PACKINGS CORPORATION

Bristol, New Hampshire

© IPC

P-2

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LET WOLVERINE TUBE PUT VALUE ANALYSIS TO WORK IN YOUR TUBING APPLICATIONS

$ SPECIALIZED PRODUCTS

In addition to standard copper, copper alloy and aluminum tubing, Wolverine Tube has also developed products to meet specialized requirements. Such products for example, as Wolverine Trufin®—the integrally finned condenser tube for increased heat transfer capacity and Wolverine Capilator®—the tiny capillary tube for precision metering of liquids and gases. Wolverine also works in special metals such as titanium and zirconium.

$ RIGID QUALITY CONTROL

At Wolverine Tube, industry and customer specifications are strictly adhered to. Tube sizes, tempers, alloys and surface finishes all receive constant attention.

$ LONG-LENGTH COILS AVAILABLE

For maximum handling, storage and production convenience Wolverine copper and aluminum tubing is available in long-length, level-wound and bunch-type coils.

$ SKILLED TECHNICAL GUIDANCE

The assistance of Wolverine's highly competent Field Engineering Service is available at all times to help customers specify exactly the right tube for their tubing applications.

$ MULTI-PLANT FACILITIES

Wolverine Tube's three plants (Detroit, Mich.; Inkster (for special metals), Mich.; Decatur, Ala.) assure prompt efficient service and a continuous, uninterrupted flow of products. They also assure that your copper and aluminum requirements will be met from a most exacting quality and delivery standpoint.

$ SEPARATE R&D FACILITIES

So that its customers can be assured at all times of the newest advances in tube manufacturing technology, Wolverine maintains the industry's most complete facilities devoted exclusively to tubing research and development.

$ "ONE-STOP" PURCHASING

The very completeness of Wolverine Tube's line of copper, copper alloy and aluminum tubing enables customers to increase purchasing efficiency by dealing with a single, convenient source.

$ IOA*

At Wolverine Tube these initials stand for *INDIVIDUAL ORDER ATTENTION. Because of IOA you are assured of tubing that meet your specifications, that is packaged to meet your production line requirements and is shipped to meet agreed-upon commitments.

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WOLVERINE TUBE
DIVISION OF
Calumet & Hecla, Inc.
DEPT. M, 17258 SOUTHFIELD RD., ALLEN PARK, MICH.
TUBEMANSHIP in Copper—Copper Alloys—Aluminum—Special Metals

More complete information about how Wolverine Tube can help your value analysis program can be found in any of the following booklets. Just fill in and mail the coupon for your free copy of the ones you desire.

- ☐ Statement of Scope
- ☐ Wolverine Trufin Catalog
- ☐ Refrigeration Tube Catalog
- ☐ Titanium Data Folder
- ☐ Wolverine Tubemanship Catalog
- ☐ Capilator Leaflet
- ☐ Commercial Tube Catalog

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COMPANY_____

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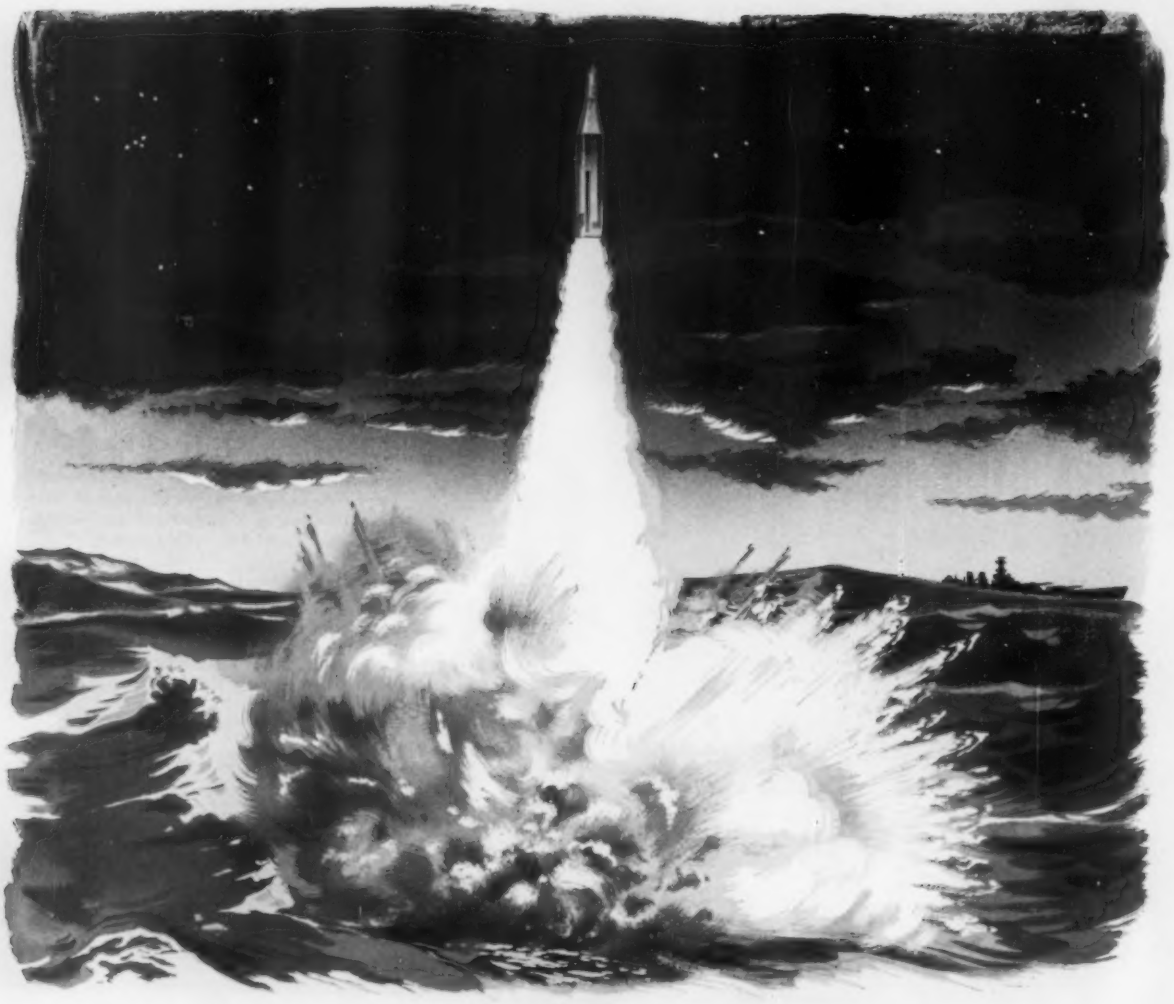
PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA.
SALES OFFICES IN PRINCIPAL CITIES



R/M ASBESTOS-PHENOLICS

molded stock saves tooling up for prototype parts

Why pay for expensive dies and equipment for molding high-temperature test parts of reinforced plastics? Machine them from standard rods and tubes available from R/M in a broad range of sizes.

R/M asbestos-phenolic molding compounds have proved themselves in the hot spots of virtually every U.S. missile. They exhibit uniform ablation at extreme temperatures for nose cone or rocket engine environments. And they assure high strength-to-weight ratio, structural integrity and shock resistance, and low thermal conductivity and diffusivity.

The superiority of R/M Pyrotex® molding compounds stems from the use of extra-long spinning grade asbestos fibers.

You can rely on R/M technical data and engineering help. Send for details.

Billet of R/M Pyrotex molding compound.

RAYBESTOS-MANHATTAN, INC.

Reinforced Plastics Department, Manheim, Pa.

SPECIALISTS IN ASBESTOS, RUBBER, ENGINEERED PLASTICS, SINTERED METAL

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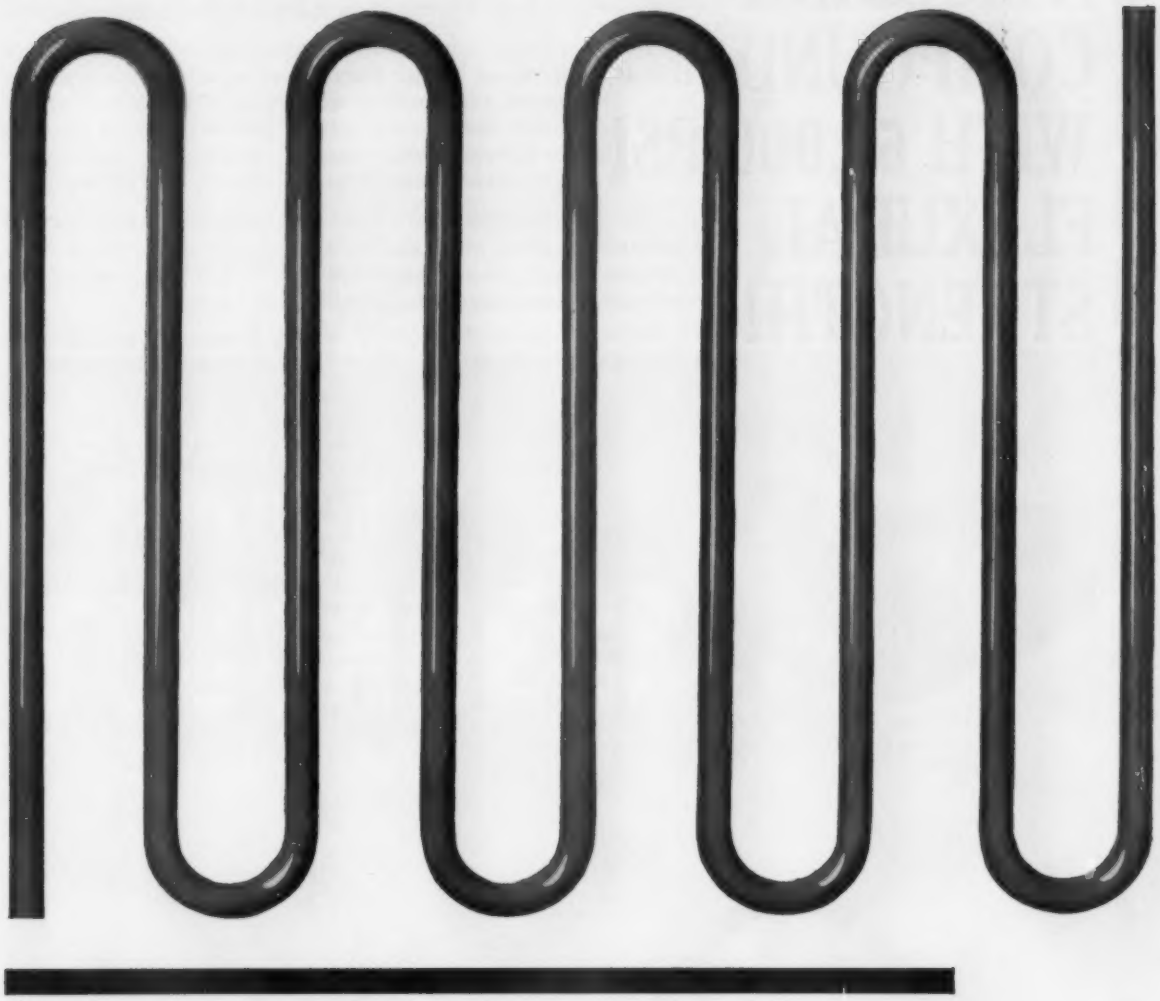
TURN TO ROCHESTER STEEL TUBING . . .



your #1 pipeline to FORMING FACILITIES

Lower cost without lower quality — that's what Rochester Steel Tubing's serpentine forming facilities offer refrigeration people. The secret is in our extensive and unique multiple forming facilities, coupled with tubing know-how. Result: lower cost, meaning real savings to you. Add to this Rochester Steel Tubing's rotary-straightening facilities and you get flat-as-a-pancake serpentines held to close dimensional tolerances. This speeds up wire welding for higher production and more savings. Such facilities and such care help give meaning to Rochester Reliability: to provide you with refrigeration tubing that works the way you want it to work for as long as you specify. More details? Write or wire Rochester Tubing Sales Manager.

GM

Rochester Reflects Reliability

GENERAL MOTORS

R P

STEEL TUBING BY ROCHESTER PRODUCTS

ROCHESTER PRODUCTS DIVISION OF GENERAL MOTORS. ROCHESTER. NEW YORK

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A MOLDING COMPOUND WITH 65,000 PSI FLEXURAL STRENGTH!

"SCOTCHPLY" Reinforced Molding Compound Type 1100 opens up new possibilities in critical design areas. This new epoxy-fiberglass compound combines outstanding uniformity and high strength far in excess of other molding compounds.

This is why Design Engineers at Detroit Arsenal selected "SCOTCHPLY" Type 1100 as a test material for their swimming test rig wheels. This application demands a lightweight, corrosion resistant material to meet stringent strength and durability tests. For example: Bureau of Standards rim test requires 100,000 revolutions for a steel rim; "SCOTCHPLY" Type 1100 rims exceeded this requirement by 4,350,000 revolutions.

The outstanding performance of Type 1100 is due primarily to an exclusive 3M manufacturing process which produces a uniformity of coating previously not obtainable. This results in a uniform flow in the molding process and a precise uniformity of glass-resin distribution in the finished part.

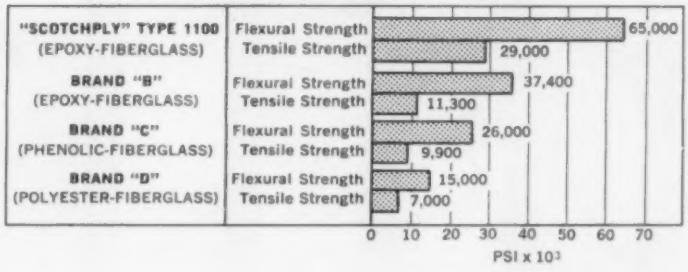
For information on "SCOTCHPLY" Molding Compound Type 1100, write: Reinforced Plastic Division, 3M Co., Dept. XAB-51, 900 Bush Ave., St. Paul 6, Minn.

The "Fox" swimming test rig is presently under development by Ordnance Tank-Automotive Command.

Comparison graph shows that the flexural and tensile strengths of "SCOTCHPLY" Molding Compound Type 1100 top other reinforced molding compounds.

MOLDING COMPOUND COMPARISON GRAPH

(ROOM TEMPERATURE PROPERTIES — ½" GLASS FIBERS)



TEST WHEEL FOR THE "FOX" SWIMMING TEST RIG IS MOLDED FROM "SCOTCHPLY" TYPE 1100 MOLDING COMPOUND.

SCOTCHPLY®

BRAND REINFORCED PLASTIC

"SCOTCHPLY" IS A REGISTERED TRADEMARK OF THE 3M CO., ST. PAUL 6, MINN.

MINNESOTA MINING AND MANUFACTURING COMPANY

3M COMPANY

...WHERE RESEARCH IS THE KEY TO TOMORROW

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STRIKING WHILE THE METAL'S HOT

Here in fierce heat and pressure of the forging process is seen the literal birth of *endurance* in metal. No other method compares for preserving and improving physical properties. No other method refines metal structure to comparable levels of toughness and fatigue resistance—or provides like opportunity to reinforce strength at points of stress by control of grain flow.

Similarly, no other forging source offers the unique combination of capabilities, facilities and experience found at Wyman-Gordon. Here is the industry's broadest range of hot-working equipment—in hammer and press types, in closed-die forged weight and size capacity, in materials utilization. Here, too, is professional assistance in design and metallurgical problems—continuously updated by intensive research—providing significant contributions for aircraft, missile, nuclear, automotive, diesel, gas turbine, farm machinery and heavy equipment forging applications.

A Wyman-Gordon engineer stands ready to counsel on all such applications. He brings an invaluable backlog of field-and-laboratory data showing how to use forgings to the most economical advantage. His aid, while designs are still "on the board," can lead to lower end-use costs.

TO FORGE SUPERIOR TOUGHNESS

and high ultimate strength into your critical parts

EST. 1883

WYMAN-GORDON

FORGINGS

of Aluminum Magnesium Steel Titanium . . . and Beryllium Molybdenum Columbium and other uncommon materials

HARVEY ILLINOIS · WORCESTER MASSACHUSETTS · DETROIT MICHIGAN
GRAFTON MASSACHUSETTS · LOS ANGELES CALIFORNIA · PALO ALTO CALIFORNIA · FORT WORTH TEXAS

W01

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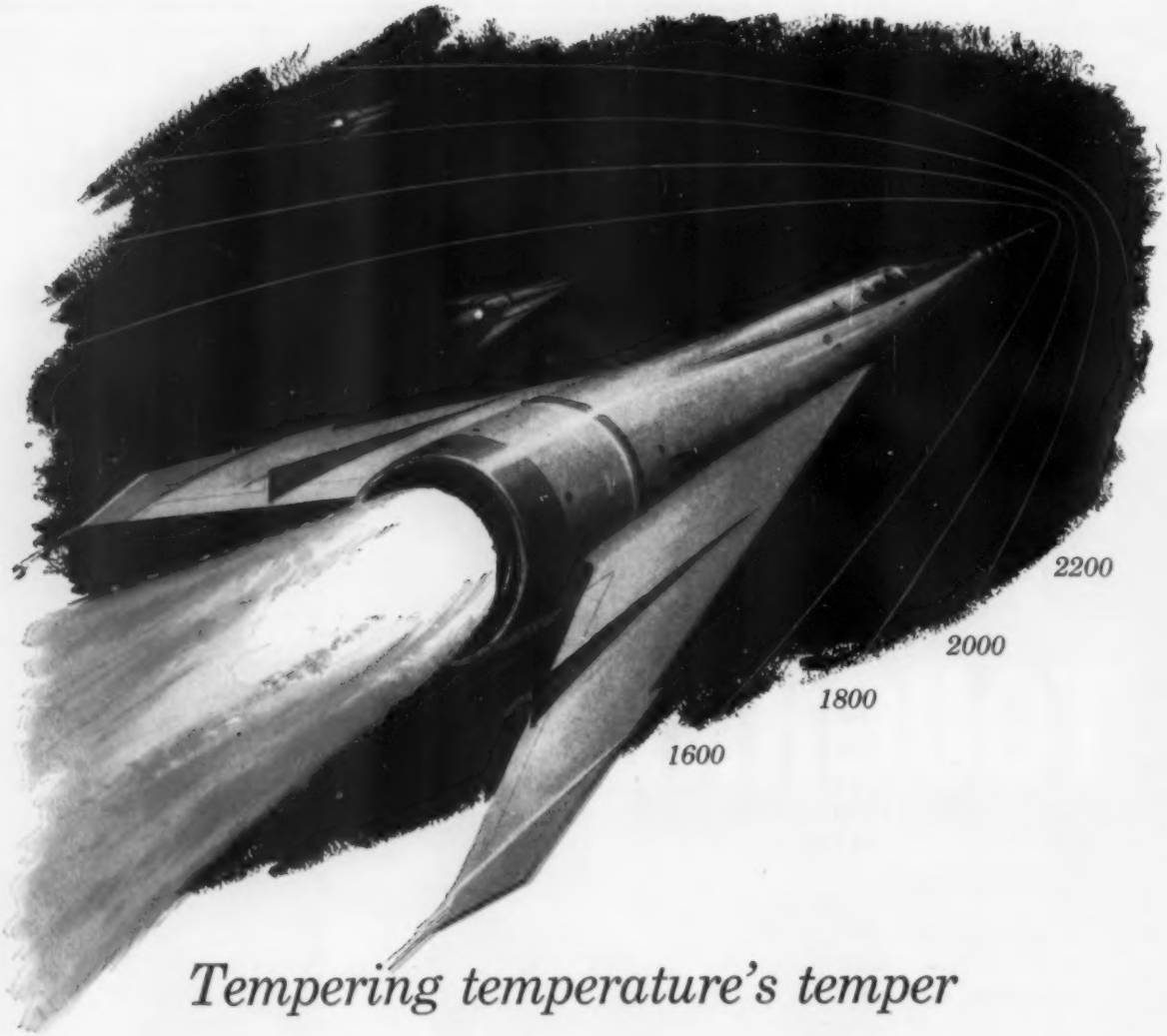
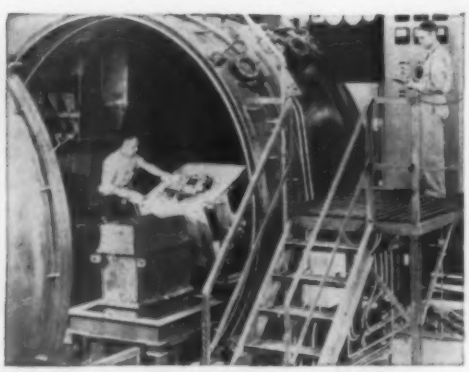


Tempering temperature's temper



Complete vacuum melting equipment is part of HAYNES STELLITE's modern plant facilities. For full details, write for 48-page descriptive booklet.

Heat of 2000+ deg. F. is generated in a supersonic jet's tailpipe. So is extreme vibration.

By far the best alloy tested for this critical component is MULTIMET alloy—one of 12 HAYNES alloys helping combat heat, stress, and erosion in the jet engine, missile, and rocket field.

HAYNES alloys are relied on for use in afterburners, turbine blades, nozzle vanes, and many other high-temperature parts. All 12 HAYNES high-temperature alloys are *production* alloys and are readily available. Some are vacuum melted. Some air melted. Some are cast, some wrought, some are produced in both forms.

HAYNES ALLOYS

HAYNES STELLITE COMPANY

Division of Union Carbide Corporation
Kokomo, Indiana

UNION CARBIDE

Address inquiries to Haynes Stellite Company, 270 Park Avenue, New York 17, N. Y.

"Haynes," "Multimet," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

For more information, turn to Reader Service card, circle No. 461

LET MUELLER MAKE IT!

Mueller Brass Co. of Port Huron is much more diversified than the name "Brass" implies . . . a lot more. In fact, because of its many and varied facilities . . . its *men, methods* and *metals* . . . Mueller is in the unique position of being able to offer true single source service.

MUELLER HAS THE MEN . . . experienced engineers with the ability to work out, creatively, tough design problems, and improve a part or components for production by the most economical method. You get sound engineering plus 44 years of practical metalworking production experience when you "Let Mueller Make It".

MUELLER HAS THE METHODS . . . when you "Let Mueller Make It", you are utilizing one single source that is able to produce parts any one of these ways: as forgings, impact extrusions, sintered metal parts, screw machine products, formed tube or as castings.

MUELLER HAS THE METALS . . . and the materials . . . to produce precision parts in aluminum, brass, bronze, copper, iron and steel in hundreds of different alloys to meet each exact requirement.

In addition, Mueller Brass Co. has complete and modern facilities for performing all types of finishing and sub-assembly operations. Another plus value is nation-wide sales engineering service.

So, in the final analysis, no matter where you fit in the American industrial picture, whether you're making missiles or mowers . . . and no matter where you're located, it will pay you to LET MUELLER MAKE IT!

MUELLER BRASS CO. PORT HURON 21, MICHIGAN

See Us At Booth 701—Design Engineering Show—Cobo Hall, Detroit, May 22-25

340

YOU CAN ADD THIS ENGINEERING TEAM TO YOUR STAFF WHEN YOU

LET MUELLER MAKE IT!

When you work with the Mueller organization, a qualified team of trained, experienced and imaginative engineers automatically become part of your staff and go to work for you. This engineering team, which includes specialists in all categories of design work and production procedures, carefully considers all aspects of your particular part or assembly and its function. In conjunction with members of your engineering department, Mueller engineers can help design or re-design your part for improved performance, eliminate, where possible, unnecessary parts through re-design by making two or three part assemblies as a single piece, and recommend the best method of production. Mueller people also consider ways of speeding your finishing and assembly operations. Production economies consistent with product quality are always a prime consideration.

This TOTAL CONCEPT engineering service, which costs no more, is available to you when you . . . LET MUELLER MAKE IT!

MUELLER BRASS CO. PORT HURON 21, MICHIGAN

See Us At Booth 701—Design Engineering Show—Cobo Hall, Detroit, May 22-25

341

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How can you use SPRING-LOCK?

THE FASTENER WITH USES UNLIMITED

As a standard removable fastener or a blind rivet

A quarter-turn locks, unlocks. Load-carrying steel arms lock securely, don't loosen under vibration. One-piece (no receptacle) simplifies blind fastening.

As a roller axle

Now used on range drawers, kitchen cabinets, file cabinets, desks. Cuts installation costs, saves time. Designed to suit. Available with or without roller.

As cup hooks

High-strength polystyrene or chrome-plated die cast zinc. Inexpensive, sturdy and good-looking. Simply and quickly installed with a twist of the wrist.

As a cabinet door strike

Millions in use on kitchen cabinets, automatic dishwashers, etc. Standard strikes available from stock, or custom designed for special contour requirements.

As a plastic shelf support

. . . with the heart of steel for extra strength. Millions now used by all major refrigerator manufacturers. Complete flexibility of head design.

What is <u>your</u> application for

SPRING-LOCK?

Send us your application inquiries. Our engineers will answer you specifically and promptly. Or, write today for the Simmons Catalog. SPRING-LOCK samples are available upon request.

New Ideas! New Products!

Booth 957

Design Engineering Show

SIMMONS FASTENER CORPORATION

1759 North Broadway, Albany 1, New York

QUICK-LOCK • SPRING-LOCK • ROTO-LOCK LINK-LOCK • DUAL-LOCK

For more information, turn to Reader Service card, circle No. 351

SYLVANIA SHAVES COSTS FOR SCHICK-IN PLASTICS, METALS AND ASSEMBLIES

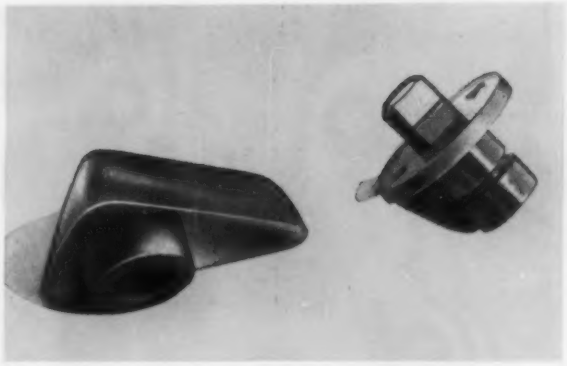
Producing the switch for a compact, 3-speed electric razor leaves almost no margin for error. It must be precisely built and still withstand the punishing abuse of day-to-day handling.

In making the switch for the new Schick razor shown below, Sylvania Parts Division meets these requirements. Our experience with a wide range of materials resulted in better electrical contacts. And our facilities assure durable, precision parts and assemblies as well as high-speed production. The combination means important economies to Schick.

For details, see captions at the right. For full information on how Sylvania custom parts facilities can benefit *you*, or for a quote on a specific project you have in mind, write Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania.

MOLDED FROM PLASTIC are parts for the switch assembly. Each must meet the tightest specifications. Example: Sylvania molds shaft and selector button from nylon, holds dimensions on both to a height and diameter of ±.0015". In addition, the flash is controlled to 1/32" because the button is a snap fit on the shaft. Since Sylvania maintains one of the world's most modern and complete lines of automatic molding equipment, it can handle volume orders for compression, injection and transfer molding. And a unique bank of rotary presses can produce millions of precision parts each day—even using phenolics and urea.

Result to Schick? Precisely molded parts—in volume!

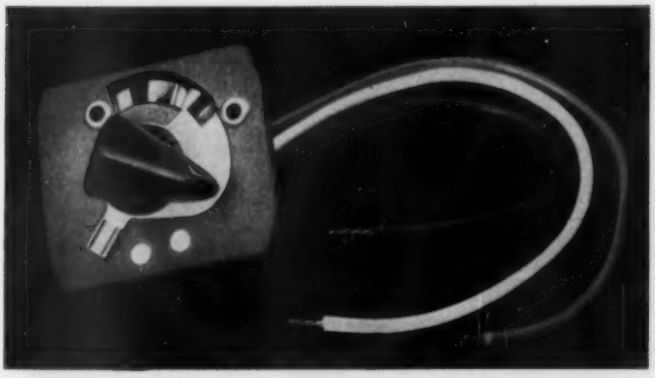


CUSTOM METAL STAMPINGS also proved important to Schick. Sylvania recommended changing the selector detent and rotor to brass, thus permitting a reduction in thickness from .015" to .010" and assuring an improvement in contact from rotor arm to detent. Sylvania made the dies necessary to produce these parts. The Sylvania metal stamping facility includes multi-slide machines, vertical presses and specially developed machines to help solve your problems.

Result to Schick? Positive electrical contacts assured while a 5° offset on the selector rotor is maintained to within ±1° day in and day out.

CUSTOM ASSEMBLY by Sylvania of the switch assembly is handled by our corps of trained specialists. Many of our customers have found that Sylvania can often deliver completely assembled and packaged products—using either all Sylvania components or a combination of some Sylvania and some customer supplied—*at lower cost than is possible in the customer's own facilities.*

Result to Schick? Thousands of completed, durable and precision assemblies per month.



NEED CUSTOM WELDING OR WIRE? Sylvania supplies both. To help you meet your welding needs, Sylvania has developed new high-speed, high-volume techniques and advanced welding equipment—automatic and semiautomatic. To help you with wire, only Sylvania of all major manufacturers makes all three types of bare wire — alloy, clad and plated. They're available in a full range of sizes, too—.002" to .250". Where necessary, Sylvania will precision-roll wire into ribbon connectors that offer high reliability when the circuitry calls for wire wrap contact methods.

SYLVANIA

SUBSIDIARY OF

GENERAL TELEPHONE & ELECTRONICS

GENERAL SYSTEM

For more information, turn to Reader Service card, circle No. 385

BATTLESHIP GUN BARREL RE-ENLISTS AT GENERAL ELECTRIC

Molybdenum Electrodes. This pair of 12″ diameter electrodes—from the G-E gun barrel—will be used for consumable electrode vacuum arc melting.

This 16″ gun barrel, from the scrapped U.S.S. Colorado, has a Space-Age job—at General Electric in Cleveland. It's now a hydrostatic pressure chamber, used to cold-form massive pieces from tungsten and molybdenum powder.

PS (for pressed and sintered) Moly and PS Tungsten, and their alloys, are new G-E products, important in today's defense effort and civilian markets.

Here are three ways to use PS powder metallurgy billets, slabs, tubes or preforms made from these refractory metals:

1. Forging and metalworking. Use PS Moly and PS Tungsten in billet and slab form for sheet rolling or forging. High densities: moly 95% minimum, tungsten 92% minimum.

2. Consumable electrode vacuum arc melting. Use electrode bars of moly in diameters 1″ through 12″. Tungsten and moly/tungsten alloys, 1″-9″. High density and high purity (99.9% minimum metal content). Good straightness—no more than 1/16″ camber on a 30″ electrode. With or without carbon additions.

3. Direct machining. For example, crucibles, furnace boats and throat inserts for missiles are machined from PS Tungsten preforms. Order the basic PS material for your own machining or, should you prefer, order the finished part ready to use. If you're looking for controlled density in tungsten, General Electric can vary it between 65% and 95%, plus or minus 3%.

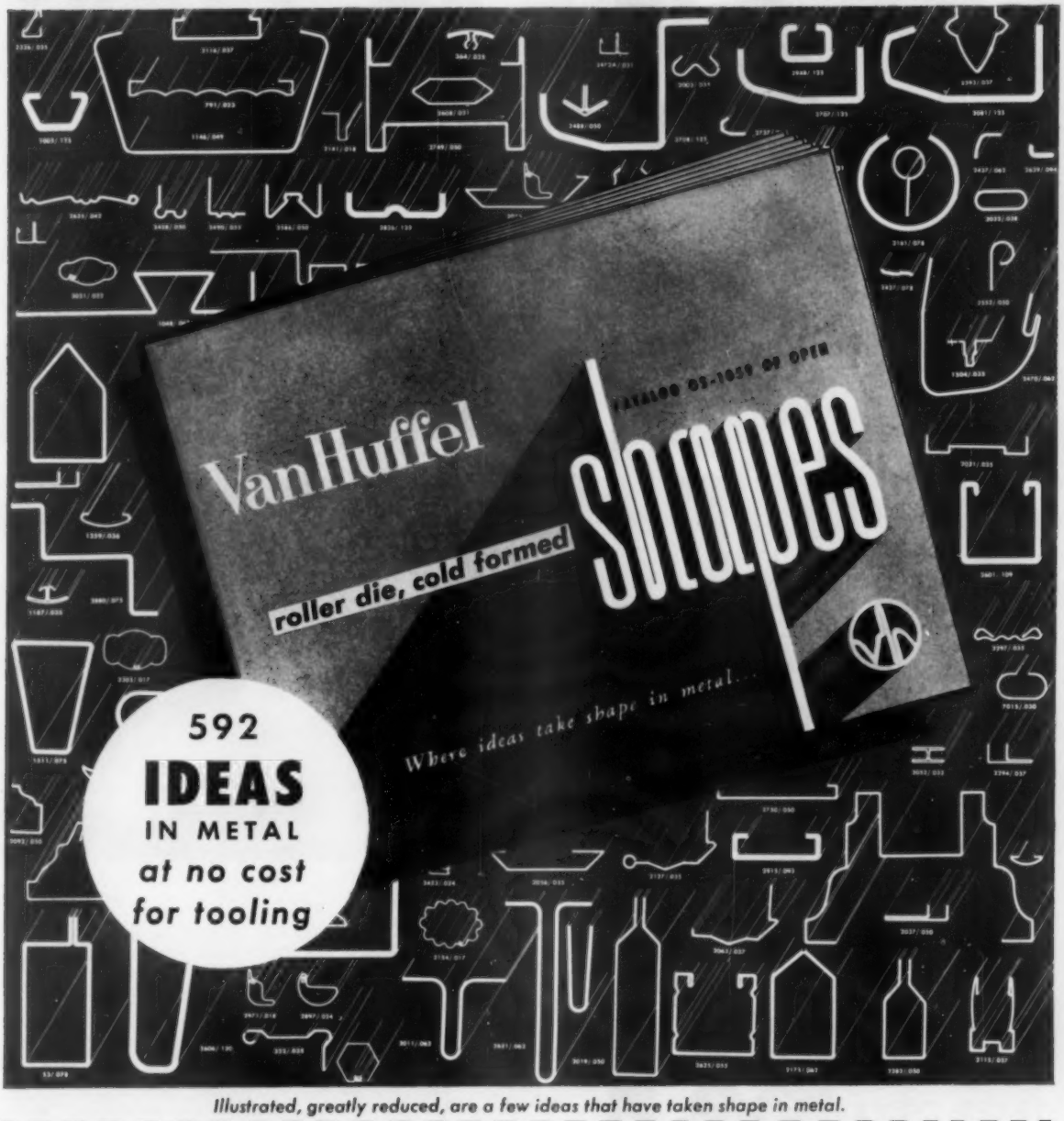
Put PS Moly and PS Tungsten, with their unique high temperature properties, to work now. Call or write Lamp Metals & Components Dept. MD-51, 21800 Tungsten Rd., Cleveland 17, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more information, turn to Reader Service card, circle No. 449

BOOK SHAPE OF THE MONTH



Illustrated, greatly reduced, are a few ideas that have taken shape in metal.

MAIL THE COUPON FOR FREE OPEN SHAPE CATALOG

48 page catalog OS-1059 illustrates (actual size) over 500 roller die, cold formed metal shapes for which rolls and dies are on hand thus eliminating tooling costs to the purchaser of any of the shapes illustrated.

Van Huffel Tube Corporation, Warren, Ohio

Please rush me Open Shape Catalog No. OS-1059.

Name ..... Title .....

Company .....

Street Address .....

City ..... Zone .. State .....

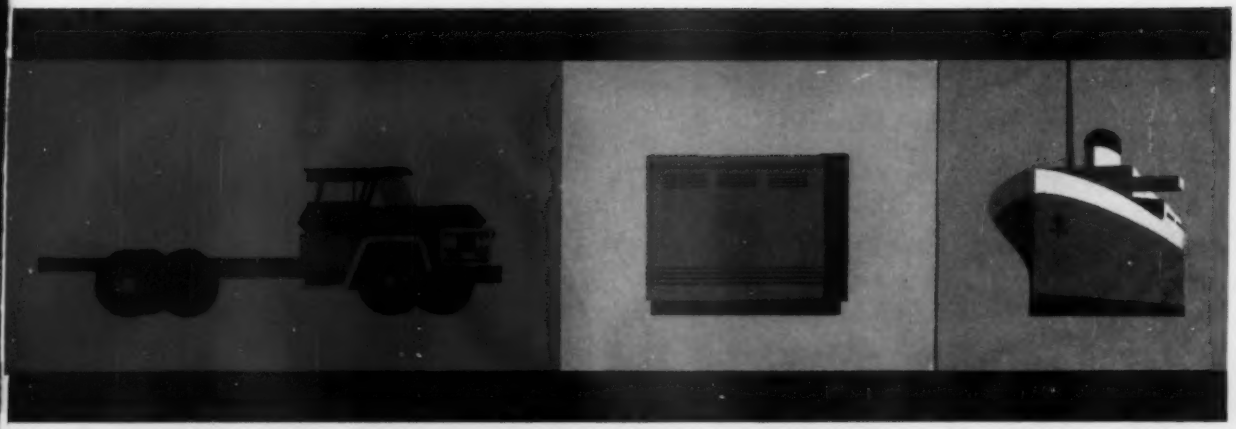
VAN HUFFEL TUBE CORPORATION • WARREN, OHIO

For more information, turn to Reader Service card, circle No. 508

DESIGN FOR
LESS WEIGHT AND
LONGER LIFE IN YOUR
PRODUCT WITH

N-A-X HIGH-TENSILE

STEEL



You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans and specifications. This versatile, corrosion-resisting, low-alloy, high-strength steel has many attractive features of special value to designers and manufacturers. For example:

- It is 50% stronger than mild carbon steel.
- It offers superior resistance to atmospheric corrosion.
- It has high fatigue life and great toughness.
- It has greater resistance to abrasion or wear.
- It has great paint adhesion, with less underfilm corrosion.
- It is readily welded by any process.
- It is stable against aging.
- It polishes to a high luster at minimum cost.
- It can be cold formed readily into difficult stampings.

With its many diversified applications in modern metal design, it will pay you to investigate N-A-X HIGH-TENSILE for savings in weight, in production time and for longer product life. A thoroughly competent metallurgical service organization is available to work with you on any application problem you may have. Write, Great Lakes Steel Corporation, Product Development, Dept. MDE-60, P.O. Box 7310, Detroit 2, Michigan.

N·A·X
HIGH-TENSILE STEEL

A PRODUCT OF

GREAT LAKES STEEL

Detroit 29, Michigan

Great Lakes Steel is a Division of **NATIONAL STEEL CORPORATION**

For more information, turn to Reader Service card, circle No. 429

fabric specialist juggles colors—even

black without color contamination

AMERIPOL MICRO-BLACK PAYS OFF AT DURO-GLOSS RUBBER COMPANY. Experts in matched colors, Duro-Gloss produces millions of yards a year of coated fabrics for the novelty trades.

Russell A. Paquette, chief chemist and superintendent reports: "We change the color line for our cements up to eight times a day. Until a year ago we used carbon black for coloring black items. After a black lot, we spent over an hour and a half cleaning our mixer and mill. Even then, we would get black contamination when mixing, and would have to run extra batches to get the right color.

"By using Ameripol Micro-Black rubber we cut our clean-up time to minutes and turn out more color runs a day. Micro-Black has good dispersion, makes it easy to control our blacks . . . get more density, more coverage."

More and more manufacturers requiring carbon black find Goodrich-Gulf's black masterbatch eliminates messy mixing . . . lowers inventory costs . . . increases production and profits.

HOW TO PUT MICRO-BLACK TO WORK IN YOUR OPERATION. Call your Goodrich-Gulf Sales Engineer. He'll come to your plant . . . help you pick the right Micro-Black for your needs . . . even test it at the Goodrich-Gulf Sales Service Laboratory. Call or write us at 1717 East Ninth Street, Cleveland 14, Ohio.

Goodrich-Gulf Chemicals, Inc.
WORLD'S LARGEST SOURCE OF SYNTHETIC RUBBER

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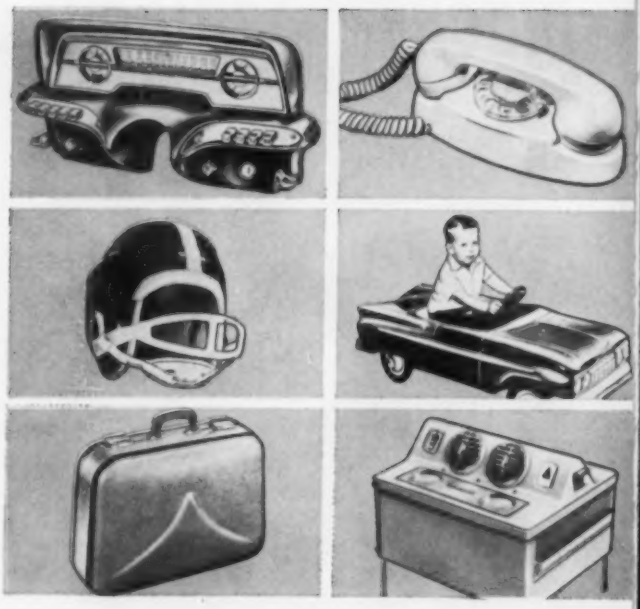
SEE NEW, EXCITING APPLICATIONS * OF TOMORROW ...TODAY!



DESIGN ENGINEERING SHOW MAY 22-25

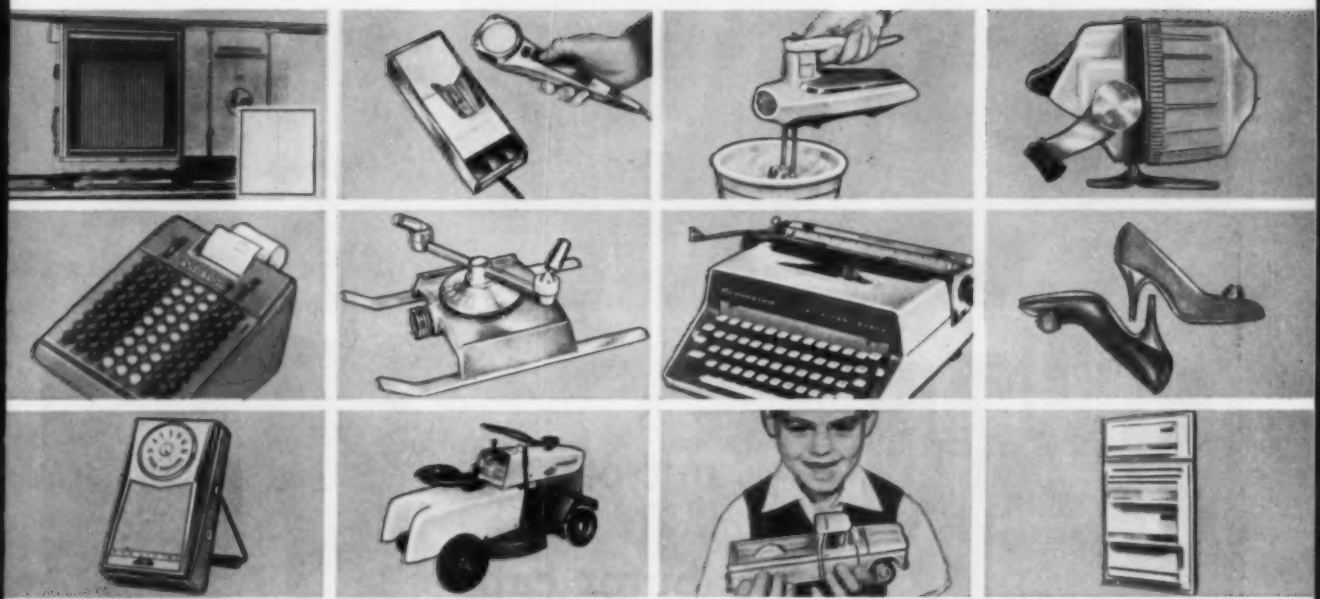
BOOTH 725

S.P.I. SHOW JUNE 5-9

BOOTH 1605

the tough, hard, rigid polymers from Borg-Warner

CY



*In the automotive, business equipment, communications, appliance, lawn & garden and other leading industries . . .

FROM ONE BASIC MATERIAL

COLAC®

BRAND

MARBON CHEMICAL WASHINGTON

MARBON B-W CHEMICAL

DIVISION **BORG-WARNER** WEST VIRGINIA

For more information, circle No. 503

8 out of 10 distributor caps in the U.S.A. are made of G-E Phenolics!

Example: this Autolite 6-cylinder cap for Chrysler. Why does Electric Autolite specify G-E 12944 Phenolic Molding Compound? Because it offers the best possible combination of performance and molding characteristics for Autolite's line of distributor caps:

1. Performance—Physical properties of the G-E 12944 parts include dimensional stability, resistance to carbonization (tracking), and ability to stand up under extremes of cold and heat (–40F to 250F). The phenolic has good electrical properties and is able to take rough handling, vibration and shock.

2. Molding Characteristics—G-E 12944 phenolic compound has good plasticity. Its special flow characteristics allow the resin to surround the multiple metallic inserts quickly and completely without disturbing their position and to fill the intricate distributor cap mold rapidly. G-E 12944 cures quickly. It permits short molding cycles — a necessity for this mass-production part.

General Electric has tailored this compound specifically for automotive use. It is an example of the care and effort we expend in formulating a compound to meet individual engineering and manufacturing requirements. We have many standard phenolics to meet a wide variety of needs, but we'll be glad to work with you in developing a special formulation to meet *your* specifications. For more information write to: General Electric Company, Section M-361, Chemical Materials Department, Pittsfield, Mass.

Phenolics-first of the modern plastics...first in value

GENERAL ELECTRIC

For more information, turn to Reader Service card, circle No. 482

Highly complex shapes,

internal and external, formed in one operation to close tolerances in

AlSiMag® CERAMICS

NEW SHAPES NOW PRACTICAL

Technical ceramic parts formerly impossible or available only by expensive machining and grinding are now practical and can be produced in volume to close tolerances and with great uniformity. They include complex and compound curves, thin walls and other difficult design features. This injection molding process is particularly suited to volume production which readily permits amortization of initial tooling costs.

MATERIALS

AlSiMag 614 (High Alumina) and AlSiMag 704 (Porous and Leachable) have found widest use. Other AlSiMag ceramic compositions are available. See Property Chart, sent on request.

APPLICATIONS

include but are not limited to:

Electronic and Electrical, such as conical micro-wave tube windows, envelopes, complex internal insulators, cups, encapsulating devices, semi-conductor assembly boats and plugs.

High Temperature, Mechanical and Heat Shock uses such as welding nozzles.

Precision Investment Casting cores of great dimensional accuracy.

Guides for wire and textile machinery.

The use of these AlSiMag ceramics is indicated when high frequencies, high temperatures, heat shock, chemical attack or mechanical wear are involved.

EXPERIENCE

More than two years of steadily increased production from this equipment has given us practical experience which enables us to promptly and accurately answer most inquiries involving complex and difficult shapes. Send blue prints or sketches. Chances are that your "impossible" designs are now practical in AlSiMag ceramics.

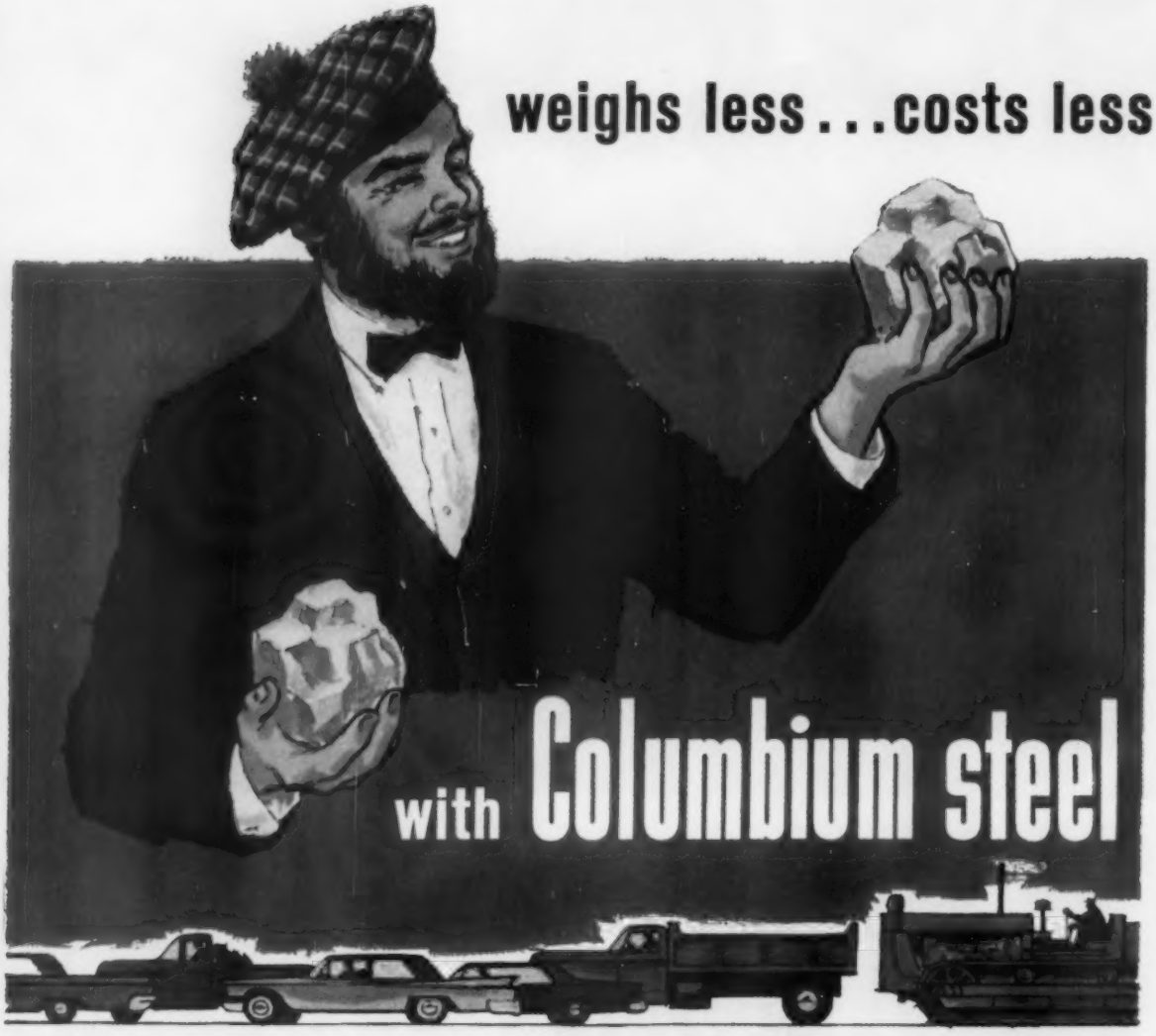
A Subsidiary of Minnesota Mining and Manufacturing Company

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
69TH YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Boston: Newton Center, Mass. • Chicago: Bedford Park, Ill. • Cleveland, Ohio • Dallas, Texas • Los Angeles, Cal. New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash.
All other export: Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.

For more information, turn to Reader Service card, circle No. 395



Whether you save nickels or pennies, the incentive is always the same—make a better product, more economically.

High strength, low alloy Columbium Steel provides greater strength with less weight for your product as well as ultimate savings by using the material in the as-rolled condition.

You owe it to yourself to investigate the new Columbium Steels. Their use means more money in *your* pocket.

Ask any steel company about the advantages of Columbium Steel . . . or write us and we will gladly provide complete information about its use for your product or product parts.

MOLYBDENUM

CORPORATION OF AMERICA

1312, Building Number 4, Gateway Center, Pittsburgh 22, Pa.

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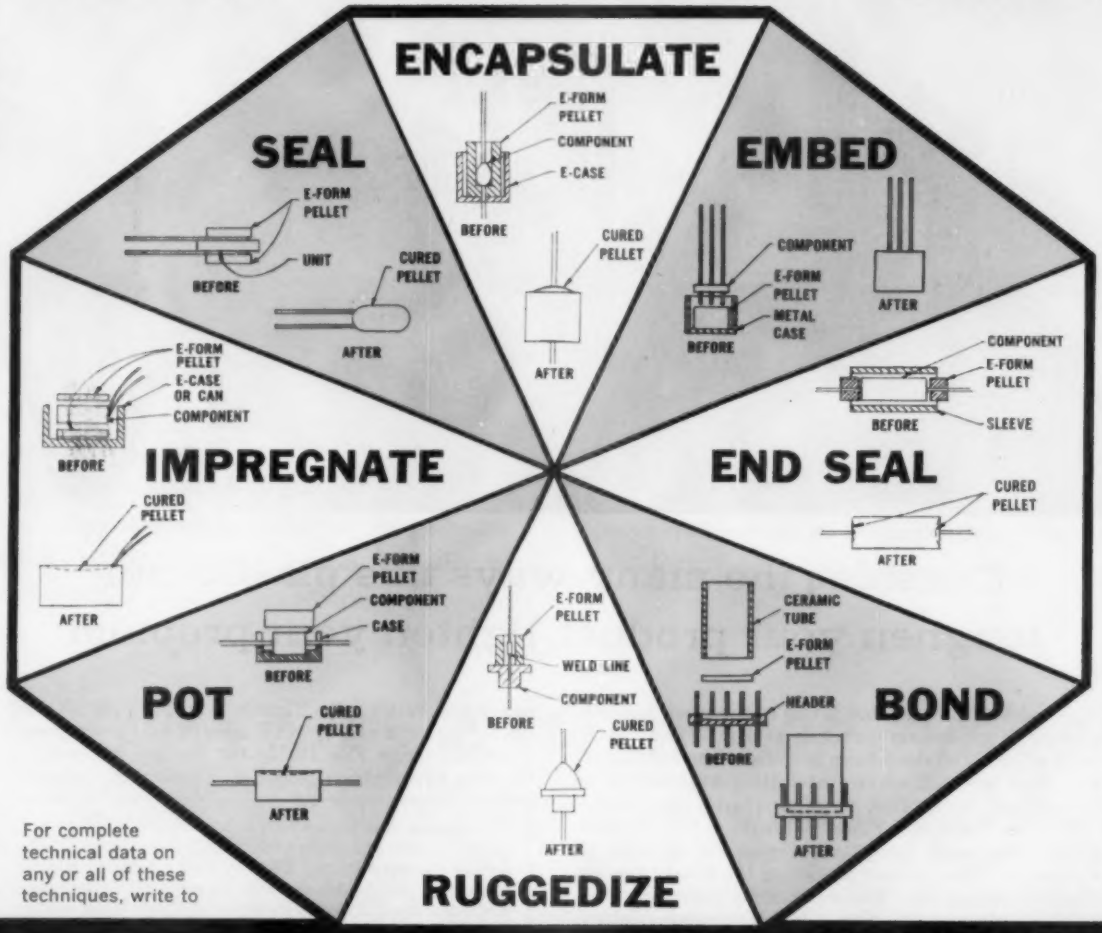
Sales Representatives: Brumley-Donaldson Co., Los Angeles, San Francisco
Subsidiary: Cleveland-Tungsten, Inc., Cleveland
Plants: Washington, Pa., York, Pa.

For more information, turn to Reader Service card, circle No. 400

8 ways to use versatile E-FORM EPOXY PELLETS

Developed to overcome the measuring and handling drawbacks of liquid epoxy, E-FORM EPOXY PELLETS are non-toxic, dry, easy-to-handle units that can be provided in the exact size, shape, volume and formulation required for any insulating, adhesive, chemical resistant or flame-resistant application! Variations of cure temperature, color, flow and viscosity, heat dissipation, thermal expansion, physical and adhesive strength, flexibility, etc., are available to raise production efficiency, save time, cut rejects drastically and raise the standard of component performance.

Here are 8 ways to use versatile E-FORM EPOXY PELLETS in your plant now:



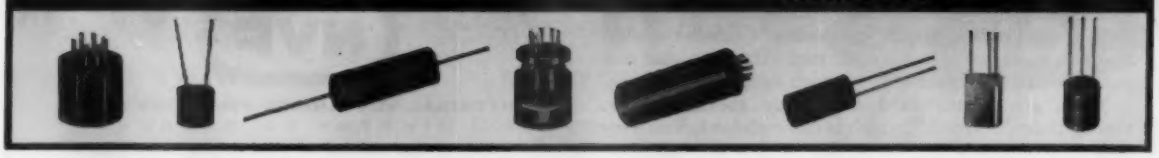
For complete technical data on any or all of these techniques, write to

EPOXY PRODUCTS

A DIVISION OF JOSEPH WALDMAN & SONS

137 Coit Street, Irvington, New Jersey

ESsex 5-6000



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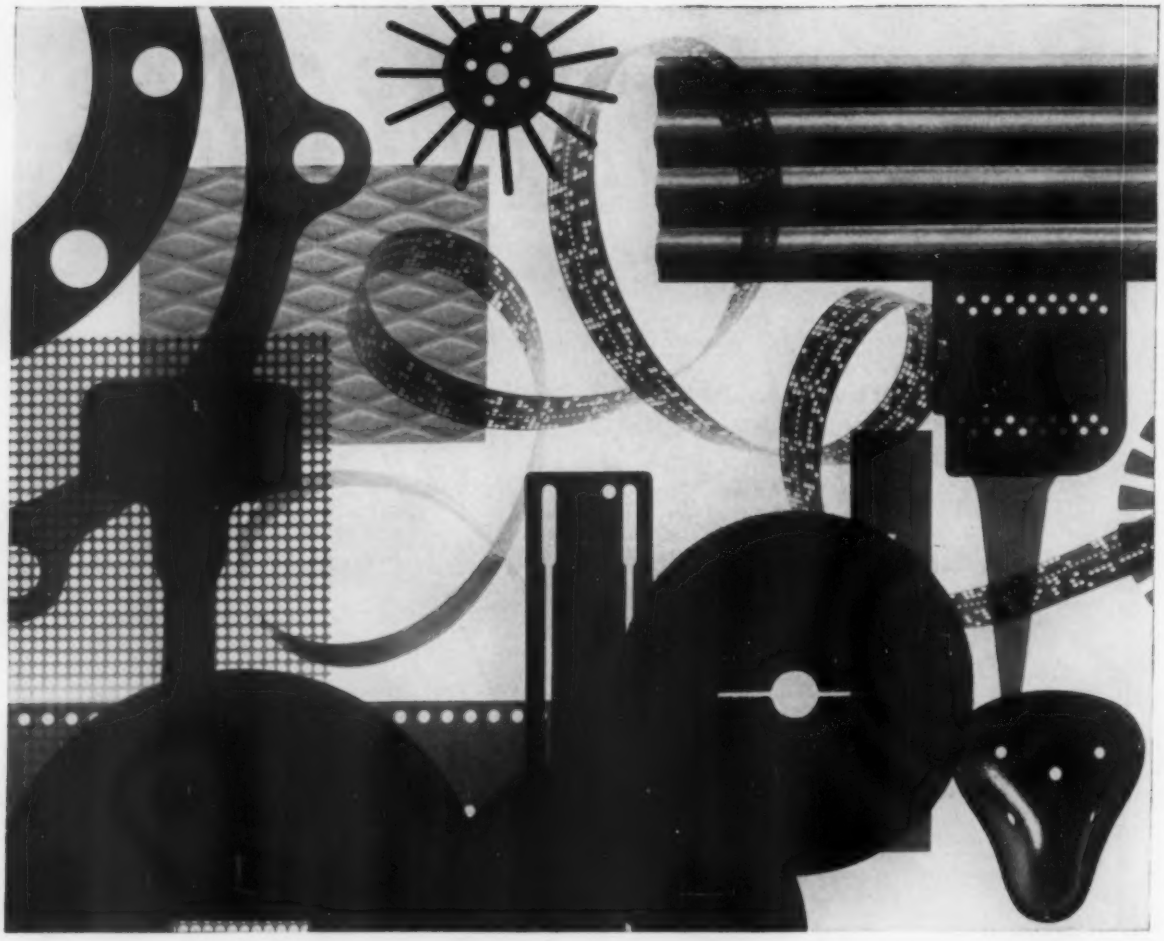


Consider the many ways this plastic can toughen your product, lighten your problem

National Vulcanized Fibre is one of the most do-more, save-more, get-around materials ever produced. Thousands of jobs well done have established its reputation. Yet there are still other cost-cutting applications to be explored, many that no other plastic can handle.

What is Vulcanized Fibre? A tough, dense cellulosic plastic. As track insulation, thousands of tons of Vulcanized Fibre are now absorbing the steady beating of trains passing over. Has superior arc resistance; high dielectric strength; is class "A" electrical insulation. Low thermal conductivity, high resiliency, great shock and abrasive resistance. Shrugs off oil, gasoline, most solvents. A most un-ordinary plastic. Weighing but half as much as aluminum, Vulcanized Fibre is one of the strongest of materials for its weight.

You can machine, punch, form, deep-draw; combine with rubber, copper, laminated plastic, and other materials. Takes polish, paint, embossing. Consider design and shape . . . you'll find Vulcanized Fibre as motor slot insulation or in intricate forms such as gear assemblies.

There are 16 standard and many special grades, among them "Pyronil", which is fire-resistant. You may well find precisely the properties needed to make your product a better buy. There's a free sample kit waiting for you at a nearby NVF sales office. Check Sweet's Product Design File 2b/Na for the one nearest you. Or write directly to Dept. KK-5, Wilmington, Delaware.

116 Choices: One Source This is the latest count of the different plastics and grades NVF can offer in your search for the *one best material*. Add to this total *the* one special grade that can be developed from scratch to meet your particular need. This full range of materials is backed by complete engineering services . . . from application assistance up to and including the delivery of 100% usable, precision-fabricated parts . . . in any quantity, on time!

Call the NVF Sales Office near you. It's a direct line to single-source help on your current materials problem.

NVF

NATIONAL VULCANIZED FIBRE COMPANY
WILMINGTON 99, DELAWARE
In Canada: NATIONAL FIBRE COMPANY OF CANADA, LTD., Toronto 3, Ontario

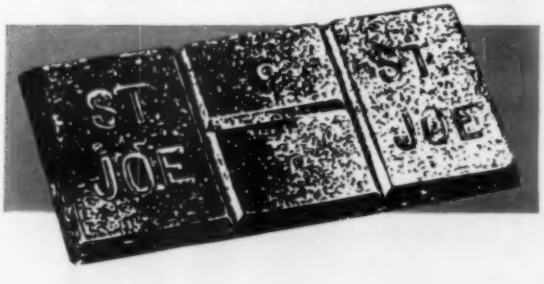
For more information, turn to Reader Service card, circle No. 374

To withstand these extreme corrosive and wear conditions a leading automotive producer manufactures their muffler from a double-thick laminated shell with four *zinc-coated* surfaces. Key baffles and rear pipe are also *zinc-coated*.

This is another example of the protective qualities of zinc galvanizing. Even if the corrosion-defying zinc skin is broken by impact or abrasion, the steel continues to be protected by zinc's galvanic action. The zinc sacrifices itself slowly while saving the base metal from rust.

No other metal or combination of metals can give this assurance of long life, at comparable cost. *Only zinc-coated steel has this combination of strength, formability, corrosion-resistance and economy.*

AND—THE ZINC *FOR THE JOB*



St. Joe was the pioneer in the production of "tailor-made" zinc electronically-matched to the requirements of the continuous galvanizing lines and today is the largest supplier of this metal to the steel industry.

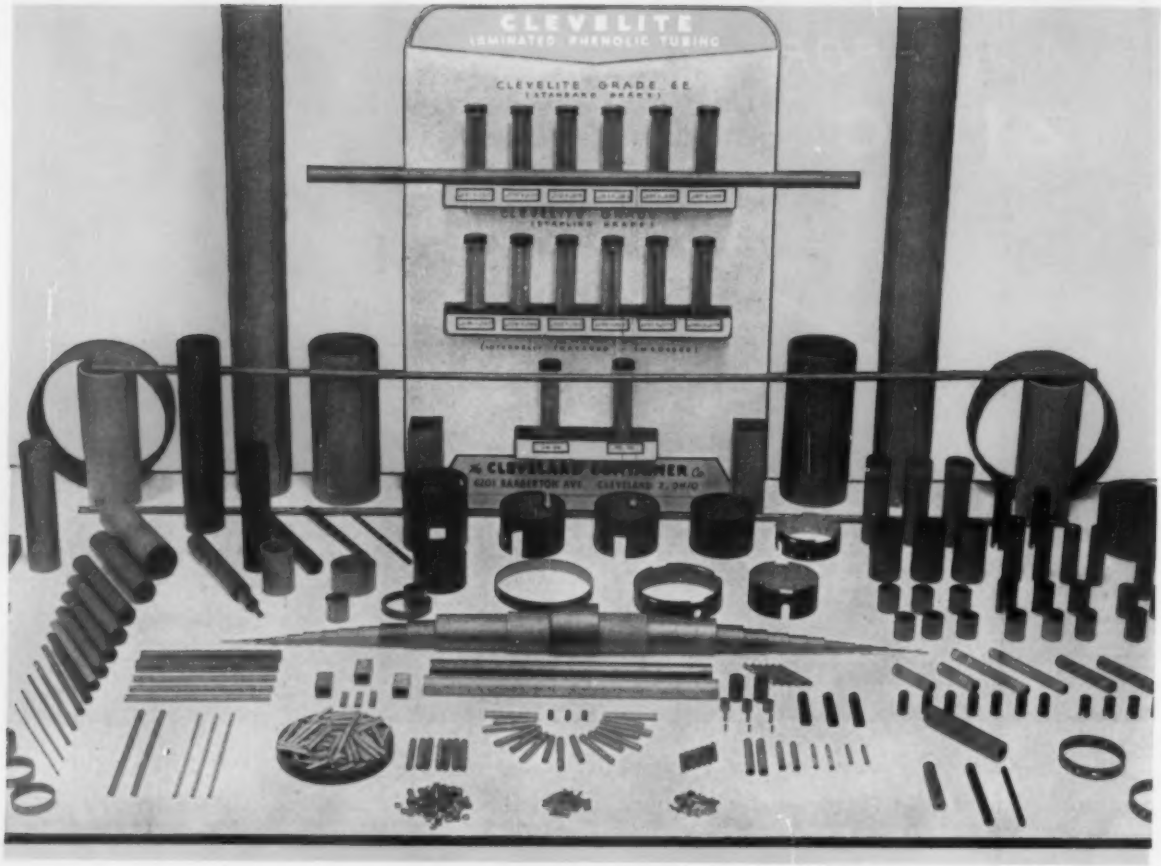
ST. JOSEPH LEAD COMPANY

250 PARK AVENUE **NEW YORK 17, N. Y.**

ST. JOE

ZN-100

For more information, turn to Reader Service card, circle No. 323



You may have uses for CLEVELITE* tubing that would save you money!

This Versatile Laminated Phenolic Tubing Has Many Applications in Products Using Tubular Parts...

These include tubing for — radio, television, electric motors, relays, controls, transformers and many other electrical products. Other uses are almost unlimited including — paint rollers, bobbins, housings, pre-forms, quality cores, spacers and sleeves.

Clevelite is structurally strong, very light and may be easily punched, machined or sawed. It has excellent electrical insulation properties, is highly resistant to moisture and is unaffected by solvents and oil.

Produced in seven grades, round or rectangular, thin or heavy wall, plain or fabricated, this tubing is used where dimensional stability and wearing qualities are required. Clevelite is economical and often replaces other materials for half the cost.

Write for latest Clevelite brochure

*Reg. U. S. Pat. Off.

THE
CLEVELAND CONTAINER COMPANY
6201 BARBERTON AVE., CLEVELAND 2, OHIO
ABRASIVE DIVISION at CLEVELAND, OHIO

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For more information, circle No. 481

TEAR OUT AND SAVE AS A FILE FOR UP-COMING 3M CHEMICAL ADVERTISEMENTS

3M PROPERTIES PROFILE ROUNDUP

SUMMARY OF 3M PROBLEM-SOLVING CHEMICAL VERSATILITY

FROM 3M CHEMICALS DIVISION . . . SPECIALTY CHEM

PRODUCT	GENERAL DESCRIPTION	PROPERTIES
KEL-F® Brand Plastic	A premium quality chloro-fluorocarbon plastic material with improved moldability and mechanical toughness, outstanding chemical inertness and thermal stability, high dielectric strength and zero moisture absorption. The plastic is nonflammable, resists virtually all corrosive media and all types of radiation.	**Chemical Resistance** Inert **Thermal Stability** −400°F. to +400°F. **Dielectric Strength** 431-510 (1000V/min.) **LOX Impact Sensitivity** 162 ft.-lbs./sq. in. **Arc Resistance** >360 sec. **Effect of Radiation** Suffer only 25% damage at 18 megarads **Electric Volume Resistivity** 2.5 x 10^{16} to 4 x 10^{16} ohms-cm (77°F.) **Tensile Strength** 4,500 psi **Compressive Strength** (0.2% offset) 5,440 psi **Modulus of Elasticity** 186 x 10^3 to 162 x 10^3 **Shear Strength** 5440-6010 psi Please note: Ranges are shown for those properties where differences occur due to the or crystalline. Specific figures will be supplied on request. Also, properties supplied are and should not be construed as guaranteed under all conditions.
KEL-F Brand Oils, Waxes and Greases	A homologous high density series of low-molecular weight chloro-fluorocarbon polymers with excellent lubricity, thermal stability and oxidation resistance.	**Chemical Resistance** Inert to oxidizing agents and strong acids; stands up in most rigorous atmospheres **Thermal Stability** To 500°F. **Dielectric Strength** Exceeds 200 volts per mil **Lubricity** Equal to pure EP additive **Specific Gravity (Oils)** To 1.93 **Service Temperature (Greases)** 0° to 350°F.
3M Brand Inert Fluorochemical Liquids (FC-75 and FC-43)	Self-healing, dielectric fluids with great thermal and chemical stability, very low pour points, extremely limited solubility, compatible with most materials of construction. Non-flammable, non-toxic, non-corrosive, non-explosive.	**Chemical Resistance** FC-75: Inert FC-43: Inert **Thermal Stability** FC-75: To 750°F. + FC-43: 600°F. **Specific Gravity** FC-75: 1.75 FC-43: 1.872 **Pour Point** FC-75: −150°F. FC-43: − 58°F. **Surface Tension** FC-75: 15 Dynes/cm at 77°F. FC-43: 16 Dynes/cm at 77°F. **Heat of Vaporization** FC-75: 8,700 cal./mol at b.p. FC-43: 11,100 cal./mol at b.p. **Viscosity** FC-75: 0.65 min (centistokes @ 77°F.) FC-43: 2.74 (centistokes @ 77°F.)
Fluorel® Brand Elastomer	A highly fluorinated, non-flammable synthetic rubber with outstanding stability in the presence of great heat, chemicals, oils and fuels. Readily processed to most military specifications or other critical end uses.	**Chemical Resistance** Excellent **Thermal Stability** 400°F. continuous service 600°F. + for reduced periods **Compression Set** 10% after 70 hours at 250°F. to 47% after 70 hours at 400°F. **Tear Strength** 180 **Specific Gravity** 1.8 **Fluorine by Weight** 60% **Mooney Viscosity** 135 (ML4/212°F.) **Solubility** Esters and ketones
Cardolite® Brand Epoxy Resin Flexibilizer NC-513	An extremely fluid compound used in epoxy resin applications. It is non-extractable . . . improves thermal and mechanical shock resistance, without affecting strength, corrosion resistance, electrical or aging properties.	**Viscosity** 50 cps @ 25°C. **Epoxide Equivalent** 525 **Odor** Slight **Chemical Resistance** Excellent **Volatility** 1%
3M Brand Paper Chemical FC-806	A fluorochemical paper size which imparts excellent oil and grease resistance, water repellency, wax, asphalt and carbonizing dope hold-out to the treated paper, while not affecting its normal characteristics.	**Appearance** Dark green liquid **Medium** Isopropyl alcohol **Flash Point** 70°F. (isopropyl alcoh **Chromium** 4.5% **Hold-Out** 0.05-0.2% concentration holds out molten wax, hot asphalt, many varnishes and lacquer. Soluble phatic
HC-912 Paint Primer Concentrate	A resilient, non-oxidizing, non-pigmented primer base with strong holding qualities which improves paint performance by minimizing blistering and flaking of paint on nearly any surface.	**Flash Point** 50°F. **Solids Content** 21% **Average Solvent Ratio** 42% Xylol 58% Acetate **Application** Brush or spray
Turpol® Brand Rubber Plasticizer NC-1200	A non-extractable plasticizer for rubber which adds more permanent softness and solvent resistance to rubber . . . has a wide range of compatibility with various synthetic rubbers.	**Hardness** 5-10 (Shore A) **Specific Gravity** 1.20 @ 77°F. **Color** Amber **Odor** Mild Terpene **Storage Stability** Unlimited
FURA-TONE® Brand Resin NC-1012	A unique low viscosity furfural derivative which serves as an extremely efficient antozonant in neoprene and butyl rubber compounds. This thermo-setting liquid can also be used as a binder for structural applications.	**Viscosity** 20-50 cps @ 77°F. **Color** Brown **Specific Gravity** 1.110 @ 77°F. **Boiling Point** 210° C. @ 760 mm (initial)

EMICALS WITH SPECIAL PROPERTIES

APPLICATIONS

Abrasive Resistance
.011-.013 grams
(Kg Load-loss/1000 cycle)

Specific Gravity
2.1047-2.1312
(dependent on processing method)

Electric Surface Resistivity
5 x 10^{18} ohms
(77°F.)

Impact Strength
3.6 ft. lb./in. of notch

Non-flammable

...h
...psi

...e to the plastic being either amorphous ...plied are based on laboratory test data

- Commutator drums
- Potentiometers
- Tube cap connectors
- Resistors, molded
- Coated hookup wire
- Precision connectors
- Terminals
- Coil forms
- Film
- Resistor sleeves
- Insulated contact bars
- Rectifiers
- Spaghetti tubing
- Transistors
- Machined insulation
- Printed circuits and cables
- Molded tube socket bases
- Rotary electric switches
- Extruded tubing

Flammability
Won't carbonize or support combustion

Pour Point (Oils)
To −90°F.

Melting Point (Waxes)
140° to 190°F.

Viscosity
1, 3, 10 and 40 centistokes @ 210°F. in standard grades.

- Compressor lubricants for oxygen and other oxidants
- Potting and sealing waxes
- Damping fluids
- Permanent instrument lubrication
- Liquid dielectrics
- Flotation (gyro) fluids
- Pump fluids
- Hydraulic fluids
- Heat transfer media
- Sealants
- Laboratory stop cock grease

Dielectric Strength
35 KV
(liquid or vapor)
60 KV

Boiling Point
212°F.
340°F.

Radiation Resistance
25% change @ 1 x 10^9 Rads
25% change @ 1 x 10^8 Rads

Specific Heat
0.248 cal/gm/°C. @ 25°C.
0.27 cal/gm/°C. @ 25°C.

Refractive Index
1.277 (77°F.)
1.291 (77°F.)

- Nuclear power systems
- Gas turbine engine coolant
- Arc quenching fluid
- Instrument fluid
- Power transformer dielectric coolant
- Electronic assemblies dielectric coolant
- Power tube dielectric coolant
- Electronic generators and motors dielectric coolant
- Metering devices

Tensile Strength
2420 psi

Elongation
240%

Hardness
74 (Shore A)

Mooney Scorch Rating
Very superior

- Mechanical seals
- Fuel and hydraulic hose
- Brake cups
- Seals and diaphragms for metering pumps
- Lip seals
- Fuel cells
- Fire walls
- Valve stem seals
- Sealants
- O-rings
- Flexi-liners for pumps
- Air ducts
- Wire insulation
- Shaft seals
- Transmission, pump and shaft seals
- Storage tank liners

Specific Gravity
0.97 @ 24°C.

Storage Stability
Unlimited

- Coatings
- Laminates
- Flooring compounds
- Potting and encapsulation of electrical products
- Tooling resins
- Adhesives

Specific Gravity
Approx. 1.0

Solubility
...luble in water or short-chain ali-...atic alcohols. Insoluble when dry.

- Seed bags
- Wax laminate paper
- Multi-wall bags
- Metal goods wrappers
- Asphalt laminate paper
- Small parts envelopes
- Carbonizing tissue
- Corrugated containers
- Polyethylene-coated papers

Viscosity
4-10,000 cps @ 77°F.

Coverage
200-1000 sq. ft. per gallon

- Metals, including aluminum
- Smooth masonry
- Galvanized zinc sheet metal
- Wood

% Ash
Nil

Solubility
Resistance to most common solvents

Toxicity
None under normal conditions

- Printing rolls and blankets
- Gasoline and oil hose and tanks
- Diaphragm cloth
- Solvent-resistant putty
- Caulking compounds
- Tank-lining materials
- Rubber gloves
- Gaskets

Odor
Mild aromatic

Flash Point
93°C.

- Carbon structural materials
- Electrodes
- Rubber products

"KEL-F," "FURA-TONE," "FLUOREL," "TURPOL" and "CARDOLITE" are reg. TM's of 3M Co.

FOR FURTHER INFORMATION

on any of the products in the 3M Fluorochemical Family, mail coupon on opposite side of this flap.

WHAT'S YOUR SPECIALTY?

THE MORE TI

3M CHEMICALS HAVE SPECIALTIES, TOO . . . PARTICULA

ERTIES THAT HELP SOLVE DESIGN PROBLEMS. With their a
ing and product development is being advanced far beyond previousl
limits in such diverse industries as electronics, missiles, textiles, platin
automotive, rubber, plastics, packaging, and more.
Tear out and save this four-page folder. The information it contains may prove valuable to you.

3M COMPANY

THE RAW MATERIALS

To: Chemical Division
Dept. KAR
Minnesota Mining & Manufacturing Company
900 Bush St.,
St. Paul 6, Minnesota

Please send further information on (product)_____

Area of interest:_____

Please have a 3M Sales Engineer call for appointment_____

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

THAN 300
JLAR PROP-
ir aid, process-
ously accepted
ating, aircraft,

CHEMICALS

ALS OF PROGRESS

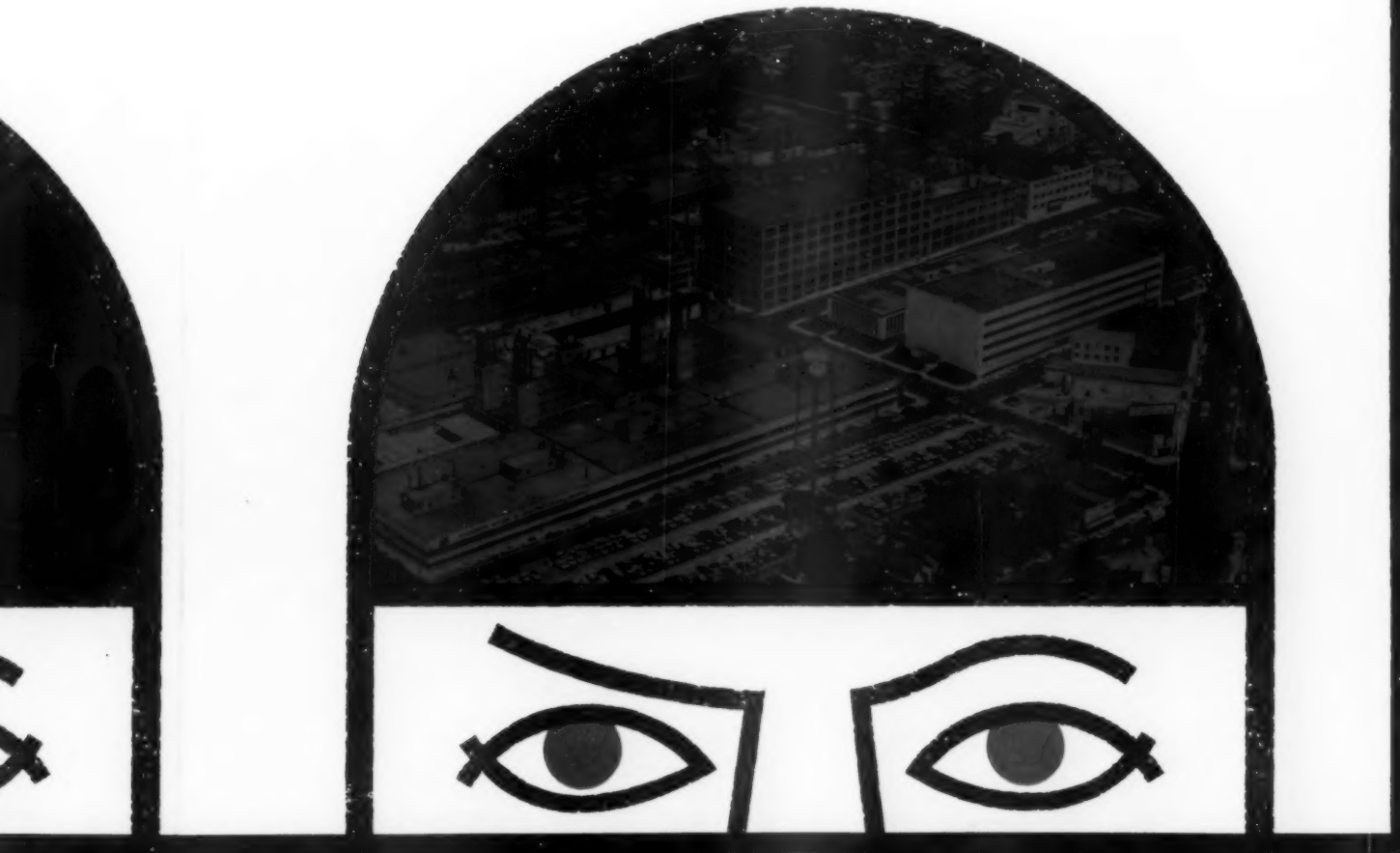
LOOK TO 3M FOR ALL YOUR FLUOROCHEMICAL NEEDS

As pioneers of fluorochemicals in mass-production quantities, 3M is your best source for fluorochemicals. Your order will command the highest possible quality and uniformity of product . . . tailored to your specifications . . . with prompt, efficient delivery. The laboratories of 3M are ready to assist you in the development of your product through use of any of the following family of 3M fluorochemicals:

■ Acids ■ Resins ■ Elastomers ■ Plastics ■ Oils, Waxes and Greases ■ Dispersion Coatings ■ Functional Fluorochemicals ■ Surfactants and Inert Liquids

3M COMPANY CHEMICALS

THE RAW MATERIALS OF PROGRESS



KNOW YOUR ALLOY STEELS . . .

This is one of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many who may find it useful to review fundamentals from time to time.

When Should Alloy Steels Be Ordered to Hardenability?

What is hardenability and how does it differ in carbon and alloy steels?

Hardenability can be defined as the capacity of steel to develop a desired degree of hardness, usually measured in depth. It is produced by special heating and cooling. Carbon steel, except in small sections, will normally harden to a depth slightly below its surface, while alloy steel can, under certain conditions, harden uniformly through its entire cross-section.

Surface hardness obtainable after quenching is largely a function of the carbon content of the steel. Depth hardness, on the other hand, is the result of alloying elements and grain size, in addition to the carbon present in the steel.

In general, where hardenability is the prime consideration, it is not too important which alloy steel is used, just so long as there is sufficient carbon present to give the prescribed hardness, and there are enough alloying elements to quench out the section. It is not considered good practice to alloy a small section excessively, since excessive use of alloying elements adds little to the properties and can, in some instances, induce susceptibility to quenching cracks.

There are, of course, numerous cases where factors other than hardenability must be considered; such factors as low-temperature impact, heavy shock, creep-resistance, and the ability to resist temper brittleness. Through-hardening, therefore, is not always desirable. For example, shallow hardening is often necessary in shock applications, because a moderately soft core is essential.

This series of alloy steel advertisements is now available as a compact booklet, "Quick Facts about Alloy Steels." If you would like a free copy, please address your request to Publications Department, Bethlehem Steel Company, Bethlehem, Pa.

Steel for Strength ... Economy ... Versatility

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

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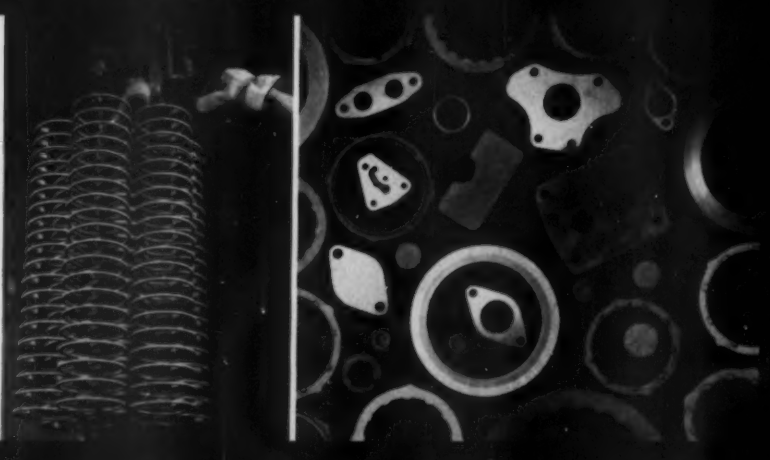
FROM AMERICA'S LEADING PRODUCER OF PISTON RINGS...

PERFECT CIRCLE PRECISION CASTINGS

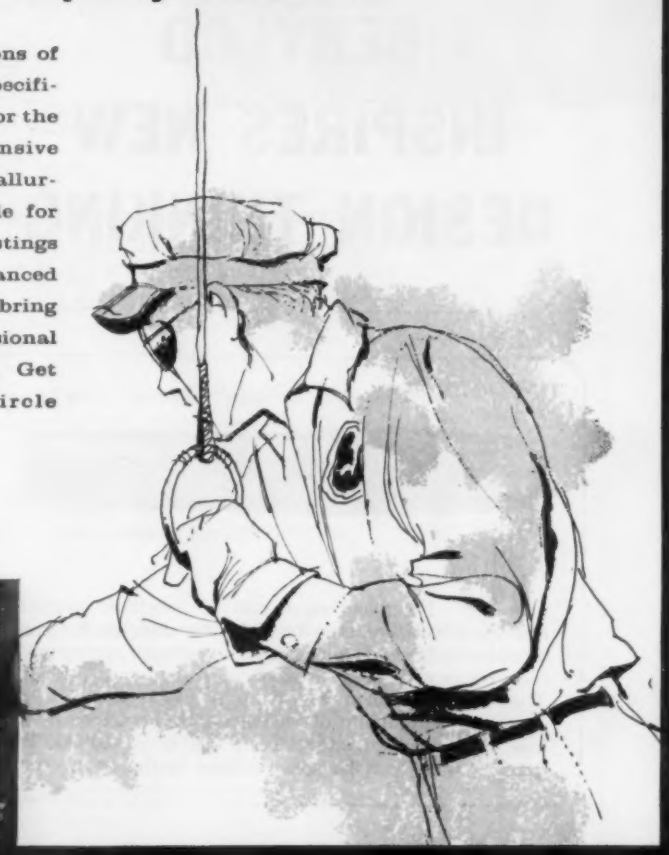
STACK-MOLD CASTING

Molds of carefully-controlled green sand are made from the pattern plate, and stacked for pouring. In the example shown at right after shake-out, the castings are 6-up in a stack 20 molds deep. Typical castings produced by this Perfect Circle process include piston rings, thrust plates, valve lifter facings and piston groove inserts.



Mass-produced to the highest quality standards

Every year, Perfect Circle produces millions of piston rings—all made to the exacting specifications that have set precision standards for the industry. Now, as the result of extensive expansion, the modern facilities and metallurgical skills of Perfect Circle are available for volume production of superior gray-iron castings to your specifications. And, through its advanced production techniques, Perfect Circle can bring you the finest metallurgical and dimensional precision at important cost advantages. Get complete information on Perfect Circle castings today!



WHIRLCAST® CYLINDRICAL FORMS

Hot metal is poured into permanent molds, and then spun at high speeds to create machineable cylindrical gray-iron castings of uniform dimension and hardness, with microstructure controlled to exacting specifications. PC Whirlcast products are offered in a wide range of sizes and materials, all precision-made for fast, economical machining with minimum stock removal.

MAIL THIS COUPON TODAY FOR COMPLETE INFORMATION

PERFECT CIRCLE CORPORATION
CASTINGS DIVISION, DEPT. ME-5
HAGERSTOWN, INDIANA

I want to know more about Perfect Circle Precision Castings.
☐ Stack-mold castings ☐ Whirlcast cylindrical forms

Name_____

Title_____

Company_____

Address_____

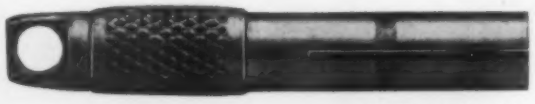
City_____ State_____

PERFECT CIRCLE

PISTON RINGS • PRECISION CASTINGS
POWER SERVICE PRODUCTS • SPEEDOSTAT
HAGERSTOWN, INDIANA • DON MILLS, ONTARIO, CANADA

For more information, circle No. 373

BERYLCO INSPIRES NEW DESIGN THINKING



3½ times actual size

Electrical connector of beryllium copper rod: By selecting a Berylco alloy, the designer met requirements for high conductivity, corrosion resistance, high contact force, and excellent resistance to creep. The connector also has enough yield strength to permit mis-alignment of the mating connector without loss of electrical contact. It is usable up to 300°F. Lead-in wires can be soft-soldered to the connector.

Bearing race cast from beryllium copper ingot: The choice of Berylco alloy on this investment casting was easily made because its high fluidity provides good surface, close tolerances, excellent detail and the ability to cast thin sections. When added to the advantages of the alloy itself, like high strength and good wear resistance, it becomes easy to see why beryllium copper is being used more and more in several casting methods.

New advances in critical parts performance now possible The ever-widening and increasingly successful use of Berylco beryllium copper alloys is opening a whole new area of design thinking on parts. The list of attributes in this amazing alloy reads like a Who's Who of famous performance characteristics: good conductivity, high fatigue strength, non-magnetic, high strength, unusual wear resistance, resistance to anelastic behavior, good corrosion resistance, excellent hardness, wide operating temperature range. Find out what these characteristics can mean to the parts you are now working on. Write for our latest BERYLLIUM COPPER BULLETIN. To assist you further, an experienced, knowledgeable staff of field and mill technicians stand ready to translate design possibilities into performance realities.

Bellows of beryllium copper strip: The design engineer on this part knows a Berylco alloy is a fine choice because its low modulus of elasticity (approx. 18.5×10^6) gives greater deflection for a given pressure change than other high strength alloys. And it has good fatigue strength with a yield strength that gives excellent usable movement range.

BERYLCO®

THE BERYLLIUM CORPORATION

Reading, Pennsylvania

For more information, turn to Reader Service card, circle No. 460

Tantalum carbide ceramics appear to have useful strengths at 4000 F and above. Recent experiments have determined that melting points range from 6360 to 6790 F in systems that contain 4.26-5.6% carbon by weight. Heat generated by their own electrical resistance was used to melt the highly reactive specimens.
Source: Technical Note D-761, National Aeronautics and Space Administration, Washington 25, D.C.

Very strong magnetic fields at cryogenic temperatures now appear possible because of the development of columbium-tin wires flexible enough to be wound into field coils. Researchers say that the intermetallic compound withstands higher magnetic fields (88,000 gauss at −428 F) while maintaining its superconductivity than any other known conductor. Such magnets could be valuable for research and electronic instruments, and for controlled nuclear fusion devices.
Source: Bell Telephone Laboratories, 463 West St., New York City.

Pyrolytic graphite coatings on spacecraft noses and wings could protect manned vehicles during long-term flights against gas temperatures of about 13,500 F and surface temperatures of 4500 F, according to recent research. The graphite is said to stand higher temperatures than any other known material, and to permit heat to dissipate from the surface at least 1000 times more readily than it penetrates. Pyrolytic graphite's strength is said to increase at very high temperatures.
Source: Missile and Space Dept., General Electric Co., 3198 Chestnut St., Philadelphia.

Filled-nylon thrust washers in a sheet metal rolling mill are said to be 24 times more durable than corresponding bronze washers. The molybdenum disulfide-filled washers, approx 8 in. in dia and 0.13 in. thick, have resisted high compressive loads without extruding, creating excessive heat, or damaging adjacent bearings.
Source: Polymer Corp., 2120 Fairmont Ave., Reading, Pa.

Thin-film memory units for computers are made by evaporating a 8-μ film of nickel-iron alloy onto a thin glass plate. Each memory unit is said to be able to store 160 bits of data and cycle in only 0.2 μsec. Because the deposited memory units cost a fraction of the price of wired ferrite systems, they are claimed to be an important advance in developing economical, high speed computer systems.
Source: Electronic Tube Div., Burroughs Corp., Plainfield, N. J.

A 5-ft dia reinforced phenolic disk is said to be the largest compression molded part yet made. The 400-lb concave disk is the aft closure insulation protecting the steel engine casing of the Minuteman missile. Made of phenolic resins reinforced with silica, asbestos and graphite fibers, the piece will withstand more than 5000 F at high pressures while holding the casing temperature to a maximum of 200 F.
Source: Dumont Mfg. Corp., 607 Irwin St., San Rafael, Calif.

Shatterproof light bulbs are being made by wrapping a glass bulb with fibrous glass yarn and bonding into a unit with silicone adhesive. The new bulb is said to last at least three times longer than conventional lamps.
Source: Lamp: Duro-Test Corp., North Bergen, N. J.; adhesive: Dow Corning Corp., Midland, Mich.

How to use Clad-Rex vinyl-clad metal in the design and engineering of school equipment and other products

Vinyl-on-Steel Folding Gymnasium Seating by Brunswick

The sheet metal nature of Clad-Rex vinyl-clad metal would seem to indicate generally how it can be used. However, the unusual characteristics added by the vinyl coating itself make the areas of usage much broader than might be expected. So as not to overlook possible applications within your product line, consider Clad-Rex as a basic material. Measure each of its advantages against the individual parts and subassemblies of your products as well as the whole enclosure. In this manner your manufacturing methods and costs, sales appeal, and product profit can be best helped.

The sales appeal of Clad-Rex vinyl-clad metal

The vinyl surface of Clad-Rex is in fact, a finish. It is available in a broad range of colors and embossed textures. Actually Clad-Rex provides an almost unlimited variety of stock and custom multi-color patterns. Special prints in register can be provided also.

The abrasion resistance of Clad-Rex vinyl-clad metal

The vinyl surface of Clad-Rex, being a poly-vinyl chloride film, offers great resistance to abrasion. Texturing effectively hides even metal-deep cuts in the vinyl surface.

The newly designed folding gymnasium seating (shown above) takes full advantage of the abrasion resistant nature of Clad-Rex vinyl-clad metals. In this application Brunswick is using a practical, yet inviting leather grain pattern. This eliminates

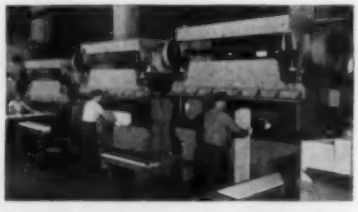
the coldness of painted metal, as well as the relatively delicate finish of wood.

The corrosion resistance of Clad-Rex vinyl-clad metal

Having all the advantages of poly-vinyl chloride, the surface of Clad-Rex vinyl-clad metal protects against acids, alkalis and other corrosive chemicals. It is free of pin holes. As a result, it offers unusual dielectric properties as well. Outdoor weatherable or stain-resistant vinyl-clad metals are also available.

The fabrication of Clad-Rex vinyl-clad metal

Brunswick's methods for fabricating Clad-Rex vinyl-clad metal are much like they used for bare sheet metal.



Finishing, of course, is not needed. Press and brake forming, crimping, punching, expanding, etc., are all practical.

Most important to any remarks about fabrication—although Clad-Rex is obviously different from bare metal, the unusual quality of the vinyl-to-metal bond tends to minimize the difference. As a result, Brunswick fabricates within their own facilities without complex or unusual techniques or tooling.

Although Clad-Rex vinyl-clad metal parts can be assembled with stud and projection resistance welding, some limitations in spot and seam welding do exist. Until the present research for a solution is completed, other conventional methods of joining should be used.

A source of engineering service

Take full advantage of the engineering and research facilities of Clad-Rex. Call or write for Report 6101, "How to Use Vinyl-Clad Metal in the Design and Engineering of Commercial Furniture". *Simoniz Industrial Products, 11512 West King Street, Franklin Park, Illinois (Phone Gladstone 1-2323).*

24C

Clad-Rex Vinyl-Clad Metal is a product of

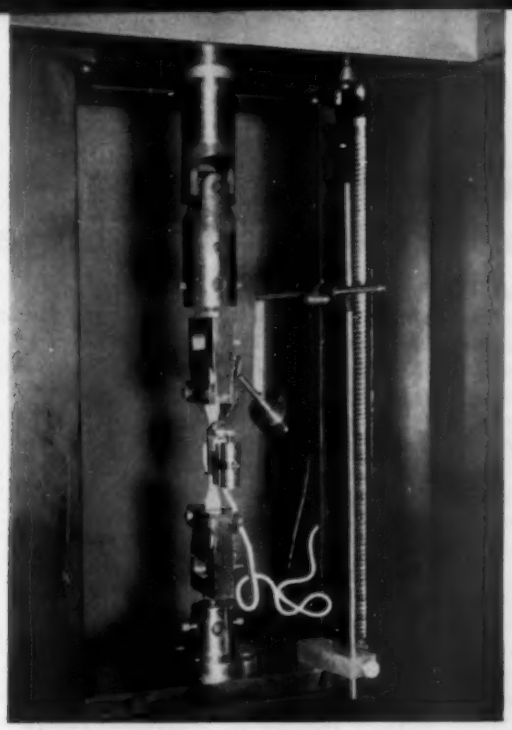
RESEARCH • DEVELOPMENT • ENGINEERING

SIMONIZ INDUSTRIAL PRODUCTS

A Division of Simoniz Company

CLAD-REX VINYL-CLAD METALS • SIMONAIRE FOAMS AND INDUSTRIAL CHEMICALS
SIMONIZ RESEARCH, DEVELOPMENT AND ENGINEERING

For more information, turn to Reader Service card, circle No. 329



The tensile test

What's Wrong with Data on

Reinforced Plastics

by Harry Raech, Jr., *Dapon Dept., Food Machinery and Chemical Corp.*

Here is a candid, highly critical look at standard mechanical tests used today: the specimens, the techniques, and the interpretation of data. You may not agree with all of the author's views —but they will stimulate your thinking.

■ Physical tests for reinforced plastics have been direct, and possibly legitimate, heirs of metals tests. In general, test specimens are similar, test jigs are similar, and test methods are similar.

Unfortunately, the two classes of materials are too dissimilar in nature to justify the similarities in the measuring techniques used. For example, metals are malleable, whereas reinforced plastics have little or no elongation and flow.

To go further, metals exhibit a classical stress-strain curve which is a perfectly straight line to the proportional limit, and up to this point physical properties can be calculated with a high degree of accuracy. Glass-reinforced plastics, on the other hand, have two distinct slopes in the stress-strain curve. These two slopes are followed by catastrophic failure rather than a long period of elongation. Furthermore, reinforced plastics have shown vastly reduced

cyclic physical properties when strained above the first transition point in the stress-strain curve—not at all characteristic of most metals.

Basic problems common to all

Several basic problems are common to virtually all physical tests for reinforced plastics. Following are two of the most important.

Human error—The ideal physical test is one in which test specimens have no dimensional tolerance, in which preconditioning and test conditions need no stipulation, and in which interpretation of test results requires no prior experience. Unfortunately, such a test has not been devised. In practice, variations in results from laboratory to laboratory virtually always arise—in large part from lack of technique, lack of conformance to technique, or lack of proper interpretation. In brief: human error.

In testing reinforced plastics, the greatest single source of human error is in preparation of the laminates. Provided with perfect resin, hardener and reinforcement, an experienced laminator can provide, at will, 3σ deviations in laminate quality. Consequently, perhaps the most important portion of a test is the selection of a highly skilled laminate technician. This will provide maximum assurance that the specimen represents not less than the average quality obtainable and, ideally, the maximum quality achievable, in order that safety and ignorance factors may be applied.

Testing speed—Most physical testing done today is predicated on simulating, within practical limits, the conditions of static loading. However, an increasing proportion of applications for reinforced plastics, e.g., in aircraft, missiles and autos, involve relatively high loading rates. Fortunately, data so far developed indicate that both strength and stiffness of reinforced plastics increase markedly under high loading rates. Both factors are favorable to reinforced plastics, but both also lead to overdesign.

Seven common tests: their problems and interpretation

There are three basic sources of standard physical test methods for reinforced plastics: 1) ASTM—American Society for Testing Materials, 2) ARTC—Aircraft Research and Testing Committee of the AIA (Aerospace Industries Assn. of America), and 3) Federal Specification L-P-406—test methods applicable to U. S. Government contracts.

The ASTM reference is perhaps the widest used since it is the most broadly applicable. Government contracts usually stipulate conformance to Federal test methods. The ARTC test methods are usually modified versions of the original Federal Specifications. An accompanying table lists corresponding test methods for physical properties of reinforced plastics as designated by each of these three references. All three methods have similarities—and also weaknesses—in common.

1. Tensile tests

Tensile is the simplest of the mechanical tests, a fact that is reflected in the similarity of the three test methods. Specimens are based on the "dumbbell" or "dogbone" specimen used in metal testing. Usage has generally kept the thickness of reinforced plastics specimens at 0.125 in., though the methods provide for specimens of other thicknesses.

ARTC specimens are wider in the gripping area than those of ASTM or L-P-406. The greater width provides better transfer of load from the grips, particularly when testing the harder plastics, or when testing at high temperatures where grips may tend to slip.

Testing speeds are similar for all three methods.

Specimen radius a problem—One of the problems of specimen preparation peculiar to tensile testing is preparation of the undercut radius. Tensile test specimens commonly fail in the radius, despite the fact that strength calculations are based on width measurement at the center of the specimen. Failure in the radius can only mean that stress raisers occur in this area.

A preliminary investigation of this phenomenon by an ASTM committee resulted in a provisional conclusion that a radius larger than the 3 in. stipulated is desirable. However, the problem has not yet been resolved, and no true solution is in sight. The rational suggestion to reject all specimens not failing near the midsection of the specimen would

STANDARD PHYSICAL TEST METHODS

Test ↓	ASTM	AIA	Federal
1. Tension	D638-58T D759-48[a]	ARTC-11—II	L-P-406-1011
2. Compression	D695-54 D759-48[a]	ARTC-11—I	L-P-406-1021.1
3. Flexure	D790-58T	ARTC-11—VIII	L-P-406-1031.1
4. Shear	D732-46	ARTC-11—V	L-P-406.1041
5. Hardness	D785-51	—	—
6. Impact	D256-56 D758-48[a]	—	L-P-406-1071
7. Bearing	D953-54	ARTC-11—IV	L-P-406-1051

[a]Test for properties at subnormal and supernormal temperatures.

probably result in rejection of 90% of all specimens tested.

Modulus measurements differ—As mentioned before, reinforced plastics tend to have an initial straight-line stress-strain curve, with a modulus in the range of 1-5 million psi. At a certain point, which may be in the range of 30 to 50% of ultimate strength, the stress-strain curve breaks sharply and assumes a second slope with a decrease of about 10% in modulus. The break is thought to be caused by the difference in elongation between the resin and the fiber: the resin finally shears away from the glass and transfers load with less efficiency.

This "secondary modulus" curve proceeds as a straight line to the point of failure. Failure occurs catastrophically.

Both ASTM and L-P-406 prescribe that the initial modulus measured from the origin be reported as the true Young's modulus of elasticity. The ARTC method recognizes the difference between primary and secondary modulus and stipulates a "secant modulus" taken as the slope of a line drawn from the origin to the intersect of 70% of ultimate strength. In effect, this value is usually an approximate average of primary and secondary moduli. There is no standard test method which prescribes reporting secondary modulus. As a matter of fact, test data are usually reported in such a manner as to leave in doubt which of the various moduli are being given.

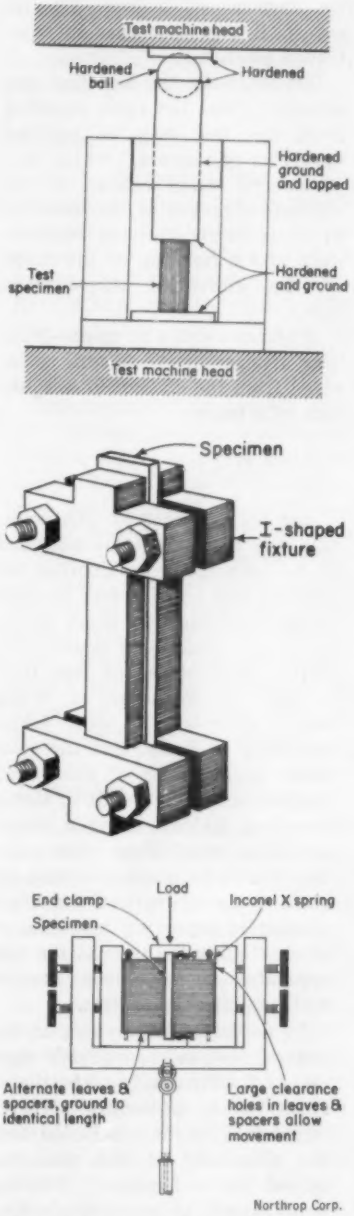
How to interpret modulus data—Misinterpretation of ultimate tensile strength is difficult. But moduli data are subject to wide interpretation.

Each of the three moduli that can be reported—initial tangent, secondary tangent, and 70% secant—has its proper use, but both the reporter and the user must be aware of which modulus he is dealing with.

If the design is such that the component will be stressed near its upper strength limit, secondary tangent modulus is the value of most concern. For lightly loaded elements, primary tangent modulus should be used. Where both loading conditions are prevalent, possibly the secant modulus is the best value to use, as it tends to be a conservative average of primary and secondary moduli.

2. Compressive tests

Compressive strength tests are possibly the most complicated and unsatisfactory of those used for reinforced plastics. Yet in many ways they are the most important. Their importance can be seen from the fact that, when loaded as a plate or beam, reinforced plastics fail in edgewise compression. Such failure usually starts as a result of the low compressive modulus of the material.



Compressive test fixtures: (top to bottom) ASTM, L-P-406b, ARTC-11.

The ASTM compression test for sheet materials is a free column test which is most specific in stating that the test is intended to measure flatwise compression (not edgewise compression). The specimen is made from stacked plates to form a rod ⅛ to 1 in. dia, and ½ to 2 in. long.

The Federal test method, though designed for edgewise compression, has significant weaknesses. The specimen, cut from a sheet, is 3 in. long, ⅛ in. thick and ½ in. wide. The specification says that ends must be ground parallel within ±0.005 in., but experience shows that parallelism must actually be held to within one-tenth of this tolerance.

In the Federal test the specimen is clamped lightly in an I-shaped jig ⅛ in. shorter than the specimen. The jig serves to prevent failure by columnar deflection, forcing failure in pure shear.

The main difficulty with this method is that failure tends to occur in the ends of the specimen protruding beyond the jig. Such failures are bearing failures, possibly better described as abortive shear. Values obtained in such failures have two shortcomings: 1) ultimate compressive strength values are substantially lower than true values, and 2) modulus values have little or no meaning.

Bearing-type failure by this test is even more prevalent at elevated temperatures, where it tends to be the rule.

ARTC-11-Method I was devised to eliminate the serious errors introduced by the L-P-406 method. A special holding fixture restrains the specimen from column failure without restraining it in compression. Specimen end caps prevent bearing failure.

Three advantages of the ARTC

method: 1) failure is in mid-column shear in a statistically high percentage of cases; 2) because of the mode of failure, modulus values are usually significant; and 3) specimens can be tested over a wide temperature range without serious inconvenience or difficulty, e.g., tests have been conducted satisfactorily at temperatures as high as 1000 F.

3. Flexural tests

The flexural strength test for reinforced plastics is perhaps the most standardized, most used, and least meaningful of the mechanical tests.

Most specimens of reinforced plastics are ⅛ in. thick and for this value all three test methods utilize the same dimensions, i.e., 4 in. long, 1 in. wide, and a 2-in. span between supports. Support and loading radii are also well standardized at ⅛ in. There is some difference in loading rates: ARTC requires 2-3 min to failure, L-P-406 requires 0.20-0.25 in. per min of head travel, and ASTM requires 0.05 in. per min of head travel. In each instance, slower rates are required for determining modulus.

The test is an unusual one: First, the data are essentially worthless for design. Data derived from the test are of no use to a designer unless he happens to be designing beams of the precise configuration of the specimen.

Second, the test can scarcely be justified on the basis that it provides comparative strength data. A true correlation between flexural properties and other mechanical properties has never been established.

In developing a flexural test for purposes of comparing various materials, the test must be tailored to the properties of the material. The so-called ultimate flexural strength, also referred to as "modulus of rupture," is not the ultimate strength of the material. The reason for this is that the flexure formula assumes that the proportional limit of the material has not been exceeded at the moment of failure. This is rarely, if ever, the case in reinforced plastics.

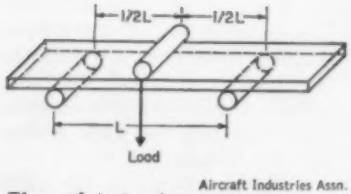
Consequently, the best that can be said is that the value reported from the test may be entitled "modulus of rupture," which is a parametric value related to the ultimate strength of the material by some fairly complex relationship, and a function of the shape of the individual stress-strain curve.

Modulus related to span—Modulus of elasticity in flexure is derived from the elastic curve equation of a beam:

$$\rho = [1 + (\tfrac{dy}{dx})^2]^{\frac{3}{2}} \Big/ \tfrac{d^2y}{dx^2}$$

For the purposes of this equation the term dy/dx is assumed to be zero. This assumption results in only small errors in situations involving only small deflections, e.g., situations introducing initial beam slopes of less than 3 deg. In instances of 3-deg slopes, error will be about 0.5%, according to *Seely*. But the relatively low modulus of reinforced plastics can easily result in slopes exceeding 30 deg, using a standard 2-in. span. Thus, compensation should be made—whether by limiting the amount of deflection allowed in reporting modulus, or by shortening the span of the test apparatus to introduce greater stiffness into the system.

Probably the only value of the flexural test, in the author's opinion, is the simplicity of both specimen and procedure. Which might lead to the conclusion that the simplicity of this test has served as a hypnotic, inducing many people to spend much time accumulating rather worthless information.



Aircraft Industries Assn.

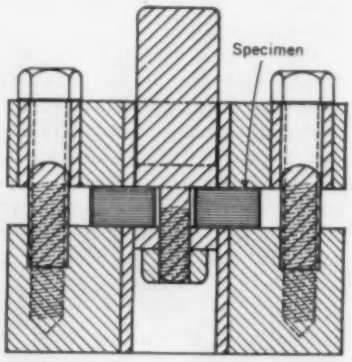
Flexural test setup.

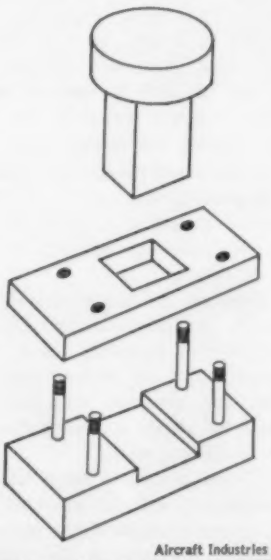
4. Shear tests

The L-P-406 and ARTC tests agree in specifying the Johnson double shear method of test. This method involves shearing a rectangular coupon, ⅛ x ½ x 3 in., using a rectangular shear plate so that two parallel cross failures occur in the specimen, as shown in Fig 4.

The ASTM test stipulates a 1-in. dia circular punch which shears an annular specimen 2 in. in dia having a 7/16-in. central hole. Thickness of specimen may be 0.005 to 0.5 in.

Speeds of test differ: ASTM stipulates a test rate of 0.05 ipm, L-P-406 stipulates speeds not




Aircraft Industries Assn.

Shear tests (top to bottom): ASTM, Johnson double shear.

greater than 0.05 ipm, and ARTC says failure should be within 120 to 180 sec (0.062-0.043 ipm).

Perhaps the most important difference between these tests is the difference in what is being measured. The Johnson test measures shear properties in one direction only; the ASTM method averages the difference in shear properties over 180 deg.

Interpretation requires care—Shear values are useful, but must be interpreted with care. Values obtained from the ASTM test represent, in effect, the type of loading which occurs in punching of materials. It averages out orthotropism of the sheet material and gives a result assuming a truly uniform sheet. This type of value is desirable in many cases.

On the other hand, because reinforced plastics are not isotropic, and because shear loading is commonly directional, shear values in a given direction are often necessary. The ARTC and L-P-406 methods provide a means of obtaining such directional shear values. By proper choice of specimen direction in the sheet, shear properties in any direction can be obtained.

Sharpness nowhere defined—A fact that should be obvious but is often ignored is that the punch edges on the shear apparatus must be maintained in a very sharp condition. Unfortunately, none of the test specifications defines sharpness, leaving this to the subjective discrimination of the user. Neglect permits edges to become slightly rounded with wear, resulting in shear values higher than those obtained from earlier tests with the same punch.

5. Hardness tests

Physical hardness of the material is an excellent index of degree of cure for thermosetting plastics, e.g., structural reinforced polyester laminates are commonly required to have a Barcol hardness of 60 for acceptability.

Only ASTM specifies a hardness test method, and that is the Rockwell test. Despite this standard, there seems to be little question that the Barcol Impressor has acquired wider acceptance for reinforced plastics because of the low cost, simplicity and portability of the instrument.

Unfortunately, there appears to be absolutely no correlation between the Rockwell and Barcol methods. For example, a large scale "round robin" series of such tests conducted by General Motors Corp. during the early stages of the Corvette program resulted in a correlation plot resembling a shotgun pattern.

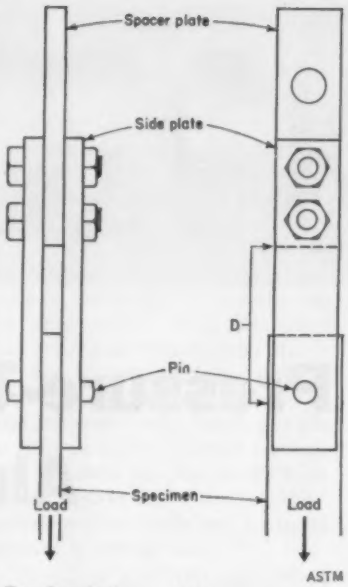
6. Impact tests

Reinforced plastics yield rather inconclusive results in impact testing owing to the fibrous nature of the break, with some tendency to drag and thus absorb energy. Both ASTM and L-P-406 specify the notched Izod test. The ASTM method also suggests use of the Charpy test (Method B).

Interpretation of impact data on reinforced plastics is extremely difficult due to lack of a clear understanding of what the test measures. Izod impact data on thermoplastic materials have been found to be related to the area under the tensile stress-strain curve. Measuring toughness of reinforced plastics by measuring the area under the tensile stress-strain curve (as indicated by *Evans, et al*) may well prove to be the preferred test method.

7. Bearing tests

The three standard test methods for bearing strength are basically the same. A rectangular specimen with a reamed hole is placed in a tensile fixture. A hardened pin is placed through the fixture and the specimen loads the hole in bearing when the assembly is placed in tension. Each of the three standard methods calls out specimens $\frac{1}{8} \times 15/16 \times 4\frac{3}{4}$ in. as well as similar testing speeds. But L-P-406 and ASTM require a $\frac{1}{2}$-in. dia pin, while ARTC requires a 3/16-in. pin. The difference in pin sizes results in a significant difference in concentration of stresses.



Bearing test.

Data Reliability a Major Problem

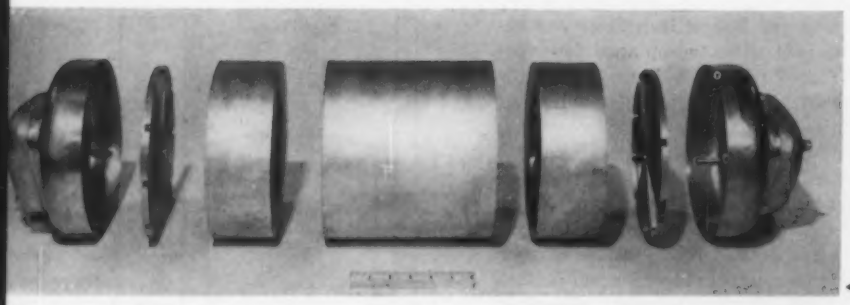
Too often physical test data are reported with no indication of their reliability, although means are available to do so. Assuming that tests are conducted by personnel of the optimum competence using perfect specimens on excellent apparatus in perfect adjustment, a spread or scatter in resulting data will still exist. The problem is to determine the significance of this spread.

One way of indicating reliability is to report the arithmetic mean and the maximum and minimum values obtained. But with small sampling the spread obtained may or may not resemble the spread to be expected in larger sampling. A method of compensating for this is the system specified in most ASTM test methods, i.e., reporting of standard deviations. Unfortunately, standard deviations are not often reported when design data are published.

References

Evans, Forsythe and Bobalik, "Prediction of Impact Resistance of Plastics from Tensile Data," *Trans. of American Chemical Soc., Div. of Paint, Plastics and Printing Ink*, Vol. 18, No. 2, '58.

Seely, F. B., *Resistance of Materials*, 2nd Ed., John Wiley & Sons, New York, p 123.



Underwater housings *of cast aluminum are used by American Telephone & Telegraph Co. for its repeater amplifiers, spaced every 20 miles along a submarine cable. The corrosion resistant housings are sufficiently pressure-tight to hold dry air at 2 atm. Because they must be electroplated, the housings cannot be resin-impregnated.*

Pressure-Tight Aluminum Housings

for electronic equipment can now be made—without impregnation—by casting in permeable plaster mold.

by Fred Dunlap, *Chief Design Engineer, Morris Bean & Co.*

■ In past years the housing of electronic equipment was a relatively simple design problem. It was usually sufficient to house equipment in a simple metal can that would keep dirt out and provide radio noise shielding. However, today's extreme environments are forcing engineers to upgrade housing specifications to improve equipment performance.

One way engineers are obtaining better performance is by sealing in under pressure a controlled atmosphere—dry air, nitrogen, large-molecule vapors, or exotic liquids. These media can of course be contained by a variety of metal housings; however, cast aluminum housings are proving particularly advantageous because of their all-around combination of properties.

Why castings?

Housings for electronic equipment can be made by many fabrication methods, such as the various casting processes, brazing and welding, deep drawing and Hydroforming. Each has its advantages and drawbacks.

Castings vs brazed and welded assemblies—One of the most important reasons for selecting a casting to house electronic equipment is that it may be the cheapest fabrication method where tough specifications have to be met. It is difficult to generalize about the cost of the various methods of fabricating housings. However, when the specification calls for pressure tightness and impregnation is not permitted, it should be clear that any fabrication method that permits leaks can be costly in the long run. Thus, it may cost more to remedy leaks in a brazed sheet metal housing than to make the housing initially from a pressure-tight casting.

Satisfactory pressure-tight aluminum castings with thin walls can be produced by a method such as the Antioch Process which produces progressive freezing from the farthest point in the casting toward the gate or riser. This process (it uses a plaster mold which has the permeability of a sand mold) has an advantage over conventional sand casting in that it permits more controlled freezing in thin sections.

Initial cost of a casting made by the modified plaster mold process can be competitive with that of a sheet metal housing. The particular housing described in the box on the opposite page can be made as a casting in fewer steps and, unlike brazed housings, does not require use of templates, holding and checking fixtures, and related fabrication equipment.

Naturally, housing walls can be brazed or welded together for short production runs or when the specification permits seams and square corners. However, welding and machining can quickly compound housing costs and can cause leakage problems. Also, sealed flanges can warp from residual stresses or heating. These problems may not be important where pressure tightness is not needed.

What about die castings?—Considerable freedom is provided by aluminum and zinc die castings; however they require a large production run to justify tooling costs. Furthermore, in order to make a die casting pressure-tight it is usually necessary to resin-impregnate the casting to seal its pores (see "Impregnants for Castings," M/DE, Oct '59, p 102). Although this may be all right for some applications it may not always be a good solution for electronic assemblies operating at

high temperatures, since heat can alter or melt the resin. Another problem with impregnants is that electroplates (which may be needed for corrosion resistance) are difficult to apply over impregnated castings.

Some of these problems may be avoided by vacuum die casting, a method which looks promising for producing pressure-tight housings. However, this process is presently confined to small castings and limited by its relatively higher cost.

Deep drawn housings—Deep drawing is usually feasible only for long production runs. However, some suppliers stock a variety of relatively inexpensive housings and these may be suitable if the assembly can be designed to fit the housing and if specifications are not too severe.

Hydroformed housings may be suitable for limited production housings when a stock housing is not suitable. Tool costs are relatively low but, like deep drawing, Hydroforming is limited to shapes that can be withdrawn readily from the die.

Why aluminum?

The increasing popularity of aluminum for electronic housings stems from its:

▸ *Pressure tightness*—Through improvements in metallurgy and casting techniques it is practical to make thin-wall aluminum castings by the permeable plaster mold process that are pressure-tight and do not require resin impregnation. Some castings made at Morris Bean & Co. can pass a maximum leakage requirement of 1.5×10^{-7} cu cm per sec of 90% nitrogen and 10% helium. This is the equivalent of holding a pressure of 2 atm for about ten years.

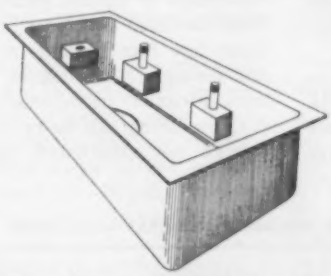
In specifying pressure tightness it may be necessary to ask the foundry to perform a water pressure or vacuum test on a limited sample or on the entire lot. A typical test consists of holding a water pressure of 15 to 20 psi for 5 min. X-ray tests have not proved reliable for leak checking.

▸ *Good mechanical properties and corrosion resistance*—Because of aluminum's high strength-to-weight ratio, housings can be made to meet most structural requirements and corrosion environments with no weight penalty.

Quite often the aluminum alloy that looks best on paper does not have the best thin-wall strength and dimensional accuracy. In general, the best alloys for housings are 355 or 356 which have a good combination of casting characteristics and mechanical properties. Best dimensional stability is obtained in the T5 (artificially aged) condition. Where the higher strength of a solution heat treatment is required, an air quench to a T7 condition provides best stability.

▸ *Dimensional accuracy*—Aluminum castings made by the permeable mold plaster process can be produced to close tolerances and with high dimensional stability and smooth surface finish. A good foundry should be able to cast pressure tight housing walls as thin as 0.1 in. Smaller sections can be made as thin as 0.08 in. These figures are "comfortable" minimums but walls can be made thinner in special cases.

Mounting hardware can often be cast into housings. Similarly, threaded studs, pressure fittings, clips and stops can be placed with good accuracy in the mold. Heat exchanger surfaces such as fins, "egg crates" and dimples are also easy to cast. Cooling devices such as passageways and tubing can be incorporated if necessary. Passageways are generally better than tubes for heat transfer and usually cost less.



A Typical Housing:

The sketch shows a typical electronic housing and the steps required to make it by casting or brazing. Essentially this housing is an open-end box 10 in. long, 5 in. wide and 4 in. deep, with a sealing flange on the open end that must be flat within 1 mil overall. The housing also contains three tapped holes in the brackets or bosses (two bosses contain threaded studs) and a 2-in. dia hole which is sealed in operation. The preliminary method analysis at right indicates that about 9 steps are required for a casting, 12 steps for a brazed assembly. Rejection rates cannot be predicted for either method until actual production.

CAST It or . . . BRAZE It?

CAST	BRAZE
1. Make pattern	1. Cut out parts
2. Make mold	2. Punch 2-in. hole
3. Cast housing with threads inserted	3. Bend corner radii
4. Pressure test	4. Braze housing walls
5. Mill top flange	5. Pressure test
6. Drill one hole	6. Bend three brackets
7. Tap one hole	7. Drill three holes
8. Hollow mill two bosses	8. Tap three holes
9. Pressure test	9. Braze brackets to housing
	10. Insert studs
	11. Mill top flange
	12. Pressure test

Maskants for Chemical

Progress in chemical milling since 1953 has been possible only with the development of maskants that effectively shield portions of the component from the etching bath. Here is a rundown of current maskants . . . how to choose them and use them.

by Henry M. Deutsch,
Organocerams, Inc.

Seven requirements

The maskant must meet seven general requirements to perform satisfactorily:

1. Most important: it must offer protection to the "non-etching" areas of a component.
2. Maintain straight lines in the etched design, regardless of its complexity.
3. Have little or no effect on the undercut factor (see previous article in April issue, p 128).
4. Have good scribing properties.
5. Be easy to apply, cure quickly, and strip cleanly after chemical milling is completed.
6. Have good stability in the liquid form.
7. Be economical, since it is not generally recoverable after processing.

In order to meet the first five requirements, maskants must have excellent chemical resistance to various etchants. They must also have adhesion that is sufficient (and can be maintained at chemical milling temperatures), yet low enough to permit manual stripping both before and after bath exposure.

In addition, the maskant must be soft enough to be easily scribed, but tough enough to resist mechanical damage when the parts are handled.

Properties of the various classes of maskants are compared in Table 1.

How to apply them

Maskants are related to paints in the same way that chemical milling is related to the ancient craft of metal etching.

Principles and some basic materials are similar but the relationship ends there. Chemical milling requirements make maskants a set of specialized tools having their own quantitative requirements (see list at left).

Three methods used

Dipping—The most common application method because of its simplicity. Reproducibility of film thickness is only fair and, if the dipping tank is large, solvent loss rate is high.

The latter occurrence leads to increased viscosity and solids in the maskant with a subsequent loss of "flow-out" and a heavy, irregular buildup of maskant at the bottom of the dipped part. The problem can be solved by continuous replacement of evaporated solvents.

Another problem: bubbles may form on the surface of the dip tank if the maskant is agitated too violently or the masked parts drip over the tank surface. The bubble problem can be corrected by using a slow-drying solvent to increase drying time and allow occluded bubbles to break.

Spraying—Although spraying of maskants is not uncommon, it is more difficult and less economical than dipping. Because of the high polymer nature of maskants, air spraying with conventional equipment is seldom satisfactory. Some common problems: cobwebbing, low film buildup per coat, and formation of pinholes (which usually cannot be detected).

Cobwebbing can be reduced, although not eliminated, by thin-

TABLE 1—MASKANTS: THEIR CHEMICAL AND HEAT RESISTANCE

↓ Maskant Material	Acids	Oxidizing Acids	Alkalis	Heat, F*
ELASTOMERS				
Acrylonitrile	Good	Fair-Poor	Excellent	250
Butyl Rubber	Excellent	Good	Excellent	300
Neoprene	Good	Fair-Poor	Excellent	200
Styrene-Butadiene	Excellent	Fair-Good	Excellent	200
PLASTICS				
Chlorinated Rubber Resins	Excellent	Good	Excellent	150
Polyvinyl Chloride	Excellent	Good-Excellent	Good-Excellent	160
Polyvinylidene Chloride	Excellent	Good-Excellent	Fair	160
Polystyrene	Excellent	Good	Excellent	150
Polyethylene	Excellent	Good	Excellent	140

*Maximum useful temperature for intermittent exposure.

Milling

Scribing *maskant on two parts to be chemically milled.* ▶

ning and the use of a slower-drying solvent. Pinholes cannot be eliminated. Some application methods such as hot spraying (at 130 F) or two-fluid container systems may also reduce cobwebbing. Hot spraying also permits the use of higher solid contents.

Electrostatic spraying, recently introduced, produces very little cobwebbing. It also has the advantage of producing films that do not contain bubbles or pinholes. This method applies the maskant at a relatively slow rate.

Flow coating—An efficient method which is more economical than air spraying. Pinholes and bubbles do occur in the film and film buildup may be inconsistent. This latter problem is caused by "wash down" of subsequent coats of maskant.

Problems associated with flow coating can be minimized by reducing fluid pressure, using slow-drying solvents, and controlling the size and shape of the orifice.

Other methods—Brush or roller coating are sometimes used on excessively large parts which cannot be handled by any of the preceding methods. Neither method produces uniform, defect-free coatings. Long drying times between coats are recommended, along with a solvent that evaporates slowly.

Silk screening is used only on very small parts such as name plates and instrument panels. It is a highly specialized process requiring specially formulated maskants.

Usually heat to cure

The three curing techniques are: air, heat, and force drying. The most commonly used, but least efficient, is air drying for periods of up to 72 hr.

Heating is the most expedient and efficient method; temperature rarely exceeds 300 F and times are limited to about 2 hr. In addition, heat cured maskants show the most consistent adhesion, highest tensile strength, lowest elongation and highest order of chemical resistance. Some prior air drying (2 to 4 hr) is usually necessary, particular with thick films, to prevent blistering or bubbling.

A typical force drying schedule ranges from 120 to 160 F for 1 to 4 hr depending on the maskant. Force dried films show less tendency to blister even without prior air drying.

Three problem areas

Controlling film thickness—Tensile strength, ease of stripping, speed of drying, chemical resistance and adhesion are closely related to film thickness. Excessively thick films retain a considerable amount of solvents which act as plasticizers and reduce tensile strength and chemical resistance while increasing elongation. When thick films are necessary, special precautions must be taken to insure that the film is properly cured.

Adhesion and stripping—Adhesion of the maskant prior to chemical milling depends on the maskant formula, type of metal being masked, and the surface condition of the part. During milling, in addition to these three factors, bath conditions become important. Some bath variables include: type of etchant, temperature, metal content (dissolved or precipitated), and the presence of wetting and defoaming agents.

As a rule most maskants are less adherent during immersion but recover adhesion on aging. In many instances bond strength increases sharply over the initial value. Since this makes stripping very difficult, parts should be stripped as soon as possible after chemical milling.

Ease of manual stripping depends on both adhesive properties and tensile strength of the maskant. High tensile strength and good adhesion are important for two reasons:

1. Without this combination of properties the maskant tends to lift along the scribe lines because of knife drag.

2. The combination of properties is needed if more than one chemical milling operation is planned.

Surface cleaning—The need for proper cleaning procedures cannot be overemphasized since improper cleaning can lead to lifting of the maskant at the scribed edges. The results of lifting are excessively large undercut factors as well as jagged or irregular lines.

The worst offenders in cleaning

TABLE 2—PROPERTIES OF THREE MASKANTS FOR ALUMINUM

Type →	Acrylonitrile Rubber	Butyl Rubber	Neoprene Rubber
Ease of Manufacture	Fair; rubber mastication mandatory	Fair; rubber mastication mandatory	Good; mastication preferable but not mandatory
Shelf Life	3-6 months	4-6 months	6-8 months
Range of Solids, %	15-25	20-25	25-35
Ease of Application			
Dipping	Good	Good	Good
Flow Coating	Good	Good	Good
Air Spray	Poor	Poor	Fair
Type of Cure	Air or heat	Heat only	Air or heat
Tensile Strength, 1000 psi			
Air Dried (24 hr)	1.0 max	—	2.0 max
Heat Cured	1.5-2.5	0.8-1.5	1.5-3

TABLE 3—PROPERTIES OF THREE MASKANTS FOR FERROUS METALS

Type →	Polyvinyl Chloride	Polyethylene	Butyl Rubber
Ease of Manufacture	Good; solution or dispersion	Good; dispersion or hot melt	Fair; rubber mastication mandatory
Shelf Life, months	6-12 months	6-12 months	4-6 months
Solids, %	25-55	60-100	20-25
Ease of Application			
Dipping	Good to fair	Poor to fair	Good
Flow Coating	Good to fair	Poor to fair	Good
Air Spraying	Good	Good	Poor
Type of Cure	Air or heat (dispersion)	Heat (dispersion)	Heat only
Tensile Strength (heat cured), 1000 psi	1.0-2.5	0.8-1.5	0.8-1.5
Resistance to Bath			
Deterioration	Good to excellent	Very good	Very good
Permeation	Fair to good	Very good	Excellent

are oil and grease, chromate stains, and caustic contamination from fumes and condensation. All of these factors can be controlled even when they cannot be completely eliminated.

Choosing a maskant for a metal

Maskant materials can be divided into two general classes: elastomeric and plastic. Although there is no definite borderline between them, and under some conditions one may behave like the other, each class still retains its identity. The most important difference between these two classes is in their thermal behavior. As a rule, elastomers are less affected by heat than the thermoplastic materials (see Table 1).

Following is a discussion of some specific maskants for various families of metals:

Aluminum alloys

Aluminum alloys are etched primarily in two types of baths: alkaline and acidic. The first is maintained at approximately 195 F and the second at about 100 F. The acidic bath is much easier from the maskant point of view: the low bath temperature and absence of oxidizing chemicals permits a rather wide choice of materials. The most common film formers in these maskants are vinyl polymers which have good chemical resistance, are easily processed, and dry by solvent evaporation alone (soluble vinyl copolymers).

Caustic milling baths, on the other hand, place severe limitations on the maskant materials. The high bath temperature alone precludes the use of the thermoplastic vinyls or the other polymers listed in Table 1, which leaves the heat resistant elastomers as prospective film formers. The choice of the individual rubbers, however, is governed by other considerations such as ease of processing, cost, shelf life, etc. These other considerations are summarized in Table 2.

Let me emphasize that the evaluation in Table 2 is general, and that individual formulations may be more significant than the individual classes of the elastomers themselves.

Ferrous metals

Carbon and stainless steels are milled in acid baths maintained at 140 to 160 F. Although temperatures are relatively low, the presence of oxidizing acids prevents the use of maskant materials attacked by these chemicals. Furthermore, the various gases and vapors (water, hydrochloric acid, nitrous oxide, hydrogen) have sufficient energy and affinity for some materials to permeate through them and set up underfilm corrosion, and outright etching if moisture is available. Table 3 lists a number of properties of some prospective maskant materials for chemical milling of steel alloys.

Here again, bear in mind that the individual maskant formulations may be more important than the classes of polymers listed. It may, for instance, be possible to formulate a vinyl-based maskant with excellent permeability properties or a butyl maskant with good solvent release and very high tensile strength.

Titanium and magnesium

Titanium and its alloys are most commonly milled in hydro-

(continued on p 241)

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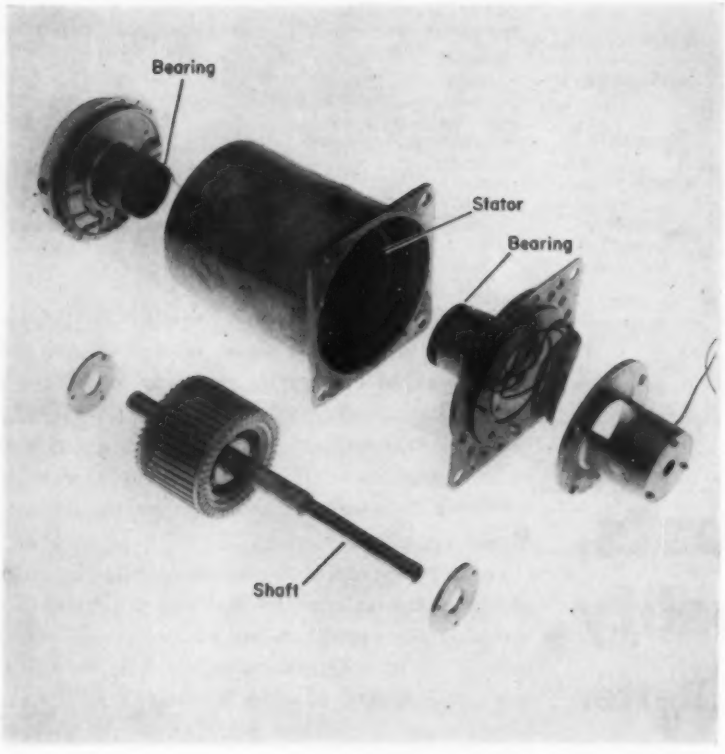
Cut Costs, Improve Quality by Better Selection of Materials

16 Winning Entries in M|DE's 5th Annual Competition

About the competition—The object of this competition is to encourage sound, imaginative and progressive use of engineering materials in the design and redesign of industrial and consumer products. The editors of this magazine impose no rigid restrictions on the procedures or criteria used by the judges in determining the award winners. However, the following factors are certainly among the most important considered: 1) importance of materials selection in the design, 2) degree of competence and thoroughness in materials selection, 3) degree of success achieved in meeting service requirements or improving old design, and 4) significance of entry in terms of setting new trends in use of engineering materials. In order to insure fair consideration of entries requiring a smaller scale of design and development than major entries, the judges split all entries into two groups depending upon their complexity and evaluated each group separately. Therefore, the award-winning products discussed on the following pages encompass a wide range of size and complexity. This year the judges awarded a First Award of $500, five Awards of Merit ($100 each) and ten Citations ($50 each). Judges were: A. E. LeVan, American Machine and Metals, Inc.; N. E. Promisel, Bureau of Naval Weapons; W. A. Stadtler, International Business Machines Corp.; and I. V. Williams, Bell Telephone Laboratories, Inc.

M/DE Special Report No. 183—May, 1961



Ceramics,

Bearings, stator and shaft *of this high temperature motor presented difficult materials problems.*

$500 FIRST AWARD

AiResearch Mfg. Co.,
Div. of The Garrett Corp.,
Los Angeles, Calif.

■ A ceramic cement normally used for strain gages and an unconventional design of nonlubricated graphite bearings have led to the successful development of a new high temperature a.c. motor.

The motor was designed to the following specifications: 0.5 hp continuous duty; 115/200 v; 3 phase; 400 cps alternating current; 10,500 rpm; 2.75 in-lb torque; and operable in aircraft systems at altitudes to 80,000 ft in ambient temperatures up to 600 F. The combination of 600 F ambient temperature and continuous duty at 80,000 ft, together with the absence of external cooling, required that the stator winding and bearing withstand temperatures of 870 F.

To determine whether the motor would meet the tough service requirements, it was subjected to a series of special and standard tests outlined in Military Specifications. These included the following tests: shock, vibration, life, acceleration, dielectric, salt spray, humidity, and load.

The insulation

To find the insulation materials that would meet the stringent high temperature conditions required an extensive investigation. Glass fiber-reinforced mica laminate (0.008 in. thick) was readily selected for the stator slot and interphase insulation, but finding an impregnate for the wound stator was a more formidable problem.

Graphite Beat Heat in 870F Motor

After considerable development work, a readily available proprietary material, Allen PBX strain gage cement, was found acceptable. It has good dielectric properties up to 1000 F, satisfactory bonding qualities, and a thermal expansion rate close to that of the other materials in the winding.

The cement is a mixture of several high temperature ceramic powders carried as a collodial suspension in a solvent vehicle. To make sure that each stator wire is completely coated, several thin coats are applied to the stator in a vacuum. During application the suspension is continuously agitated to prevent settling of the ceramic powders. Each coat is fired slowly to provide maximum adhesion and prevent blow holes.

Because the fired coating is porous, the surface is glazed using Allen SD sealant. This material is a mixture of glass frits in a solvent vehicle. After application it is fired at 700 F.

The bearing

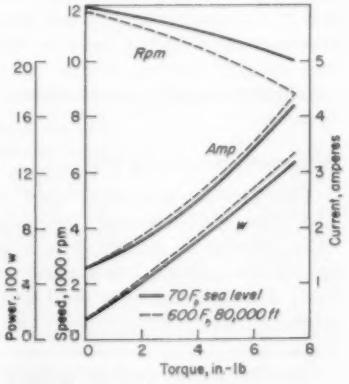
The problem of developing a satisfactory bearing was complicated by the nonlubricated design and the three-bearing configuration needed to meet a 10-lb radial load test requirement.

Graphite was selected as the most suitable material. Because of its relatively low tensile strength, however, conventional methods of mounting the bearings failed. The problem was solved by using graphite's high compressive strength to advantage. The bearings are shrink fitted into place, thus keeping them in constant compression.

To distribute the high radial bearing load it was necessary to depart from accepted practice and design each graphite bearing with a length-to-width ratio of two or more. Of course, the three-bearing configuration also helped to distribute the high radial load.

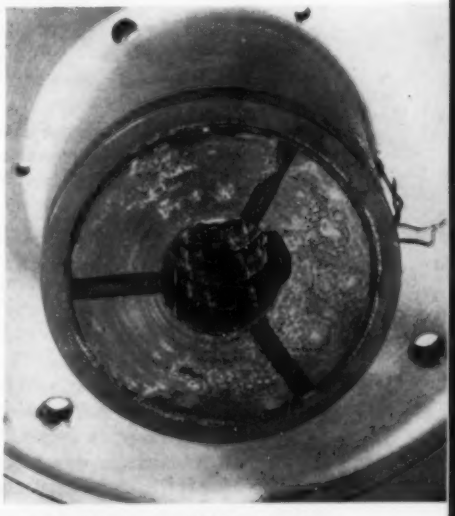
The shaft

The original shaft for the motor was nitrided Nitralloy. Although it passed all service tests, the humidity tests caused galvanic action between the graphite and the shaft. This problem was finally solved by flame plating aluminum oxide on the shaft bearing surfaces.

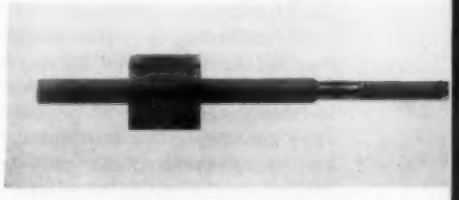


Performance *of motor.*

Stator insulation *consists of glass-mica laminate, ceramic cement and glass sealant.*



Three-piece graphite *bearings after 240-hr humidity test.*



Aluminum oxide *is applied to shaft bearing surfaces.*

High strength ceramic *is used for all moving parts of the gyro motor except the momentum ring and the laminations and winding. The motor is shown positioned in half the gimbal (top), and disassembled (bottom).*

Ceramic Gyroscope Motor Spins on Gas Cushion

$100 AWARD OF MERIT

Matt H. Riesgraf,
Project Engineer,
Development Team,
Aeronautical Div., Minneapolis-Honeywell Regulator Co.,
Minneapolis, Minn.

■ Development of a gas bearing motor utilizing alumina ceramics for a small integrating gyroscope has increased the life and accuracy of the instrument tenfold. Ceramic is used for the motor bearing surfaces which are lubricated by a thin film of gas. Use of the ceramic has also greatly improved the reliability and producibility of the gyro.

The extremely sensitive gyro is only 2.817 in. long and 2.0 in. in dia; it weighs ¾ lb. It is used in missile and space vehicle guidance systems to measure angular motion as precisely as possible without reacting to other environmental influences. These influences include temperature, pressure, vibration, shock and humidity.

The exceptional hardness and wear resistance of the alumina ceramic dictated its use for the motor. Its excellent thermal and dimensional stability suit it for use in the gimbal where mass stability is the primary consideration.

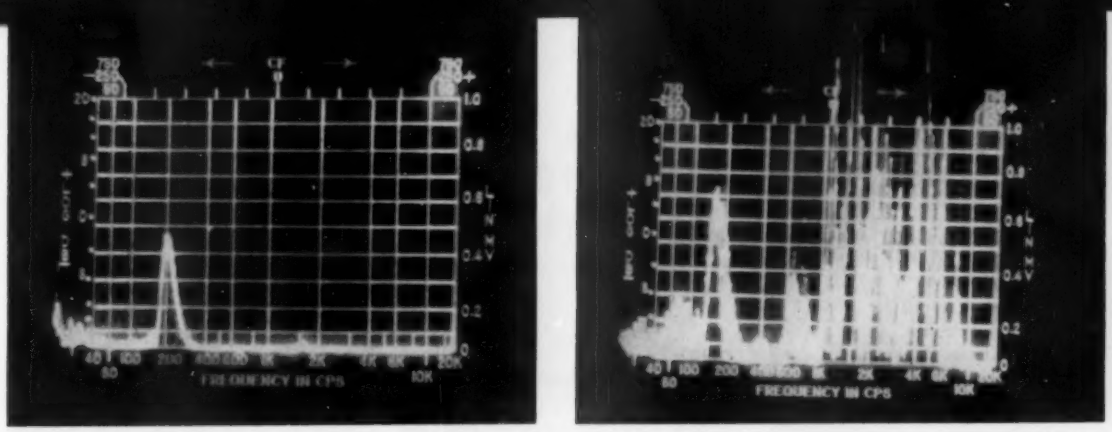
Accuracy, reliability vital

The floated gyroscope (not a new type of instrument) consists of a spinmotor sealed within a cylindrical gimbal. The gimbal, in turn, is supported by a fluid that permits nearly frictionless support.

Suspending the ceramic spinmotor on gas bearings greatly reduces all motions that are not truly gyroscopic and are, therefore, sources of error. Typical torque levels in the gyro exert a force approximately equal to the pressure of a flashlight beam on a freely suspended playing card.

The principal advantages of the new design are:

1. Long life (better than 10,000 operating hours and 5000 starts and stops).
2. Elimination of mechanical bearings whose more than 30 parts are sources of drag, drift, and noise. Bearing noise represents not only friction forces but also erratic vibrations.
3. Excellent shock and vibration resistance.



Noise-free operation *of the gyro's gas bearings is compared with the noise level of a ball-bearing unit (right). These oscilliscope traces show the 30:1 reduction in decibel level of the bearing noise.*

4. Rotational stability and structural rigidity that minimize extraneous motor movements.

5. Good dimensional stability during thermal and mechanical excursions.

Ceramic's properties best

Choice of the material for the spinmotor was a long and difficult process. One of the main problems was that materials that could be easily worked did not have enough wear resistance.

High wear resistance and smoothness are essential in minimizing the effects of starting and stopping friction. During rotation, the bearing elements are separated by a thin film of gas, so there is no physical contact and no wear. However, during starting and stopping the elements do rub over one another. Because the motor runs at 24,000 rpm these brief periods of contact generate dry friction that can damage most materials.

Many materials were tested before alumina ceramic was selected. They include: chromium-plated metals, such as steel, aluminum, and beryllium; nickel-plated beryllium; tool steel; quartz; glass; and carbides.

Properties of the alumina ceramic are given in the table. The ceramic's characteristics, other than wear resistance and smoothness, which are considered most essential for the gyroscope are:

Formability—In the green state the ceramic can be worked very easily. After firing it is as hard as sapphire. Grinding and lapping with diamond grit wheels and diamond compounds can produce parts with extremely accurate dimensions. Tolerances of ±5 μin. have been held repeatedly.

Dimensional stability—Alumina ceramics are exceptionally stable through a wide temperature range. The dimensional changes in specimens subjected to temperatures ranging from −85 F to 1500 F were within measurement accuracy. Long term creep is also low. Both of these properties are essential to meet the gyro's unusually high mass stability requirements.

Corrosion resistance—The ceramic is so inert that acids are safely used to clean contaminants from the gyro components. Cleanliness is extremely important because the running clearance in the gas bearings is less than 0.0001 in.

Elasticity—The ceramic's modulus of elasticity compares favorably with that of beryllium and is higher than that of steel. Therefore, it makes an excellent shaft material.

Dielectric strength—The material's high dielectric strength permits printed circuits to be used for motor leads. Wires might drift and unbalance the mass.

PROPERTIES OF ALUMINA CERAMIC

Specific Gravity	3.7
Softening Temperature, F	3000
Hardness, Mohs*	9
Lin Coef of Ther Exp, per °F	
77-580 F	3.6×10^{-6}
Tensile Strength, psi	30,000
Compressive Strength, psi	400,000
Flexural Strength, psi	60,000
Thermal Conductivity, Btu/hr/sq ft/°F/ft	9.68
Modulus of Elasticity, psi	42×10^6

*Ceramics are seldom measured by Rockwell and Brinell tests. This hardness equals that of sapphire.

Special production problems

Some of the alumina ceramic's properties that are design virtues, e.g., extreme hardness, pose special manufacturing problems. The best precision grinding, honing and lapping are necessary to achieve the critical requirements of the design.

Production dimensions are usually given as an "at assembly allowance" rather than as absolute dimensions and close tolerances. Mating parts are precisely finished when they are assembled.

The dimensions of a journal bearing are typical of the accuracy required for the motor. The bearing is ¼ in. in dia. It requires a diametrical clearance of 90 ±5 μin. with respect to its mating shaft. Perpendicularity, roundness and concentricity are held to similar tolerances.

Such precise tolerances require exceptional instrumentation and gaging techniques. Both assembly and measurements are performed in super-clean, controlled temperature rooms. It is absolutely essential that components be thermally stabilized during assembly.

Finishes of 3 μin. or better are required for bearing surfaces. Special quenching and lapping techniques were developed for these super finishes.

***New bladder** is made of proprietary rubber compound called Vicone.*

Fluorosilicone Bladder Safely Stores Peroxide

$100 AWARD OF MERIT

Frederick E. Clark,
Orville Markles
and Malcom Clancy,
Material & Process Section,
North American
Aviation, Inc.,
Los Angeles, Calif.

■ North American's materials laboratory has developed a proprietary rubber compound to meet severe service requirements for an expeller bladder used to store and expel 90% hydrogen peroxide. The bladder operates inside a tank on the experimental X-15 hypersonic aircraft.

The proprietary compound, called Vicone, is a combination of Viton (copolymer of vinylidene fluoride and perfluoropropylene) and silicone rubber gums.

Oxygen and steam formed by catalytically decomposing hydrogen peroxide liquid are used in the aircraft to power all accessory equipment such as hydraulic pumps and ballistic control rockets. The liquid is expelled from the bladder by collapsing it with helium gas.

How new compound evolved

The materials laboratory selected Viton rubber because of its good physical properties and its excellent compatibility with 90% hydrogen peroxide. But Viton had two drawbacks: 1) it was inflexible at approximately 0 F, and 2) it was difficult to mill and calender because of excessive nerve in the unvulcanized state.

These drawbacks were overcome by combining Viton rubber with a selected silicone rubber gum. The resulting rubber compound can be calendered to a smooth, uniform sheet which serves as the starting material for layup of the bladders.

Physical properties of Vicone are given in an accompanying table.

Bladders made of the compound did not swell, separate at the seams, leak, blister, extrude into orifices, tear or crack after they were filled with 90% hydrogen peroxide and helium gas under various pressures and collapsed 100 times at room temperature, 25 times at 120 F and 25 times at 15 F; also 100 times at room temperature while simultaneously sloshing and vibrating the tank assembly.

Other materials studied

Before developing the proprietary compound, the materials laboratory studied bladders made of CFE (chlorotrifluoroethylene)-vinylidene fluoride rubber and TFE (tetrafluoroethylene) resins.

CFE compound—Bladders made from a compound of CFE resin and vinylidene fluoride rubber were weak (600 psi tensile strength) and tore easily. Cracks formed at the bladder folds during storage. And the bladders did not pass low temperature expulsion cycling or leakage requirements. Tougher CFE-vinylidene fluoride compounds were prepared but also failed to pass qualification tests.

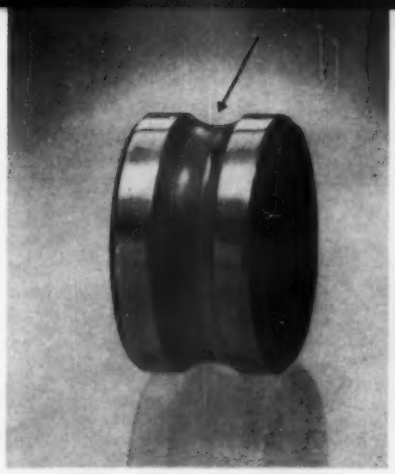
TFE compound—Bladders fabricated of TFE resin by a spray technique were better than CFE-vinylidene fluoride bladders, but they too failed to pass qualification tests. TFE's ultimate elongation of 100% was not high enough to prevent local rupture of tight folds around the standpipe during expulsion. Some of the bladders developed stressed creases after being filled and collapsed several times at room temperature.

PROPERTIES OF VICONE RUBBER

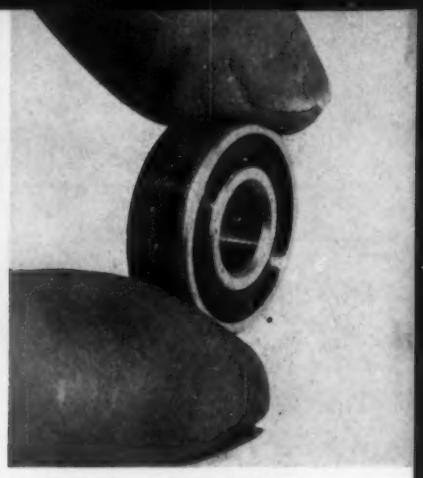
Properties ↓	Control[a]	ASTM Specimen[b]
INITIAL CURE		
Ten Str, psi	1460	1550
Elong, %	460	410
Compr Set (22 hr at 140 F), %	—	43
Hydrogen Peroxide Compatibility (120 F), cu cm/hr/sq in.	7.8	—
Seam Str, lb/in. width	77	—
POSTCURE 28 HR AT 420 F		
Ten Str, psi	1670	2300
Elong, %	465	365
Compr Set (22 hr at 140 F), %	—	27
Hydrogen Peroxide Compatibility (120 F), cu cm/hr/sq in.[c]	0.0015	—
Seam Str, lb/in. width	84	—

[a] Flat specimen cured simultaneously with a bladder in a vacuum bagging operation 12 hr at 150-380 F under a pressure of 15 psi.
[b] Cured 40 min at 300 F in a mold under a pressure of 1000 psi.
[c] Value obtained on installed bladder.

Retainer ring *made of glass-reinforced TFE filled with molybdenum disulfide. It acts as both ball separator and lubricant.*



Lubricant, *a fine layer of molybdenum disulfide (arrow), is transferred from retainer ring to bearing race by balls.*



Assembled precision bearing.

$100 AWARD OF MERIT

Employee Activities Committee, The Barden Corp., Danbury, Conn.

TFE Retainer Rings Make 575 F Bearing Self-Lubricating

■ A new miniature precision bearing is self-lubricating, yet consistently operates for over 1000 hr at service temperatures up to 575 F and under loads up to 2 lb. Key to this development is retainer rings fabricated of TFE fluorocarbon resin, reinforced with glass microfibers and impregnated with molybdenum disulfide (MoS_2).

The bearings, called BarTemp, and developed by Barden Corp., are designed for use in airborne equipment such as synchros, motors, blowers and fans. Previous bearings for such equipment have been limited to maximum service temperatures of about 300 F. Use of oil jet lubricating and cooling systems for higher temperature operation is impractical in airborne applications because of the pumping and heat transfer systems required.

In contrast to the new design, conventional lubricated bearings rarely exceed 800 hr operation at 400 F under laboratory conditions, and show poor reliability when operated at temperatures above 350 F.

Storage stability is another benefit of the new bearings. The lubricant cannot harden, dry out or become gummy.

How it works

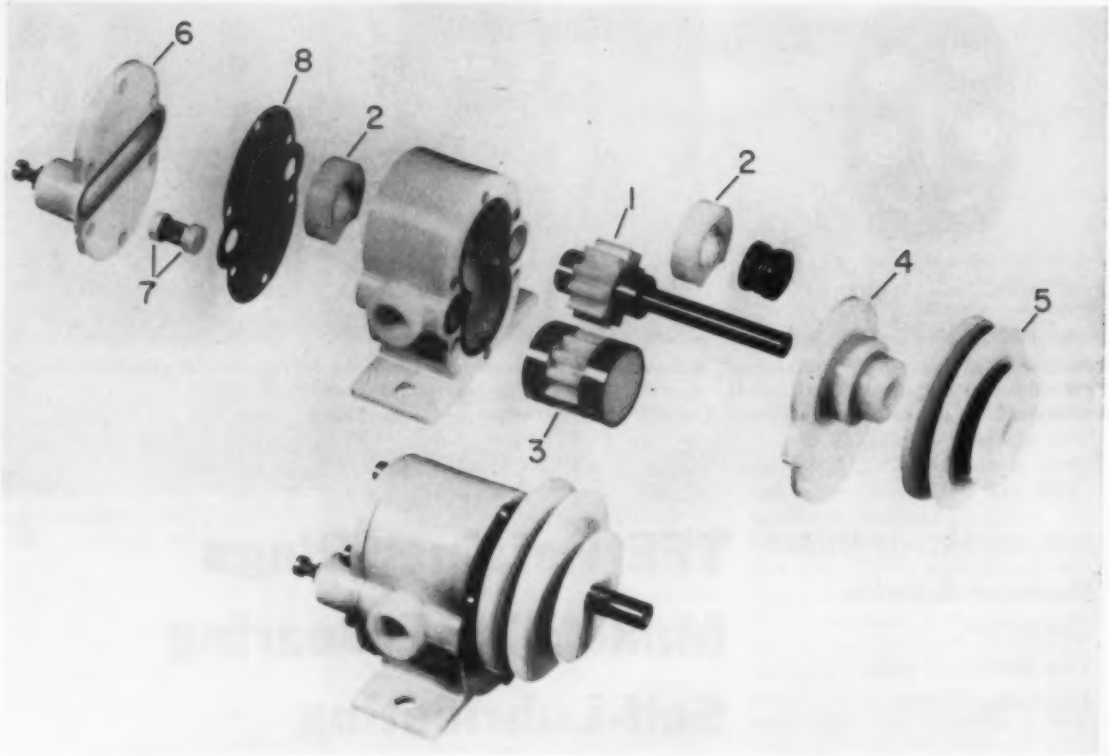
The glass-reinforced TFE retainer serves as both a ball separator and a dry lubricant. As the bearing rotates, the balls rub off minute quantities of molybdenum disulfide, depositing a light film on the raceways, as shown in a photo above. Since the transfer of lubricant is performed by precision balls, the variation in thickness of lubricant film is small—so small that the torque of the new bearings is approximately the same as that of oil-lubricated precision bearings. So long as loads are kept below 2 lb the film will not rupture and satisfactory bearing performance can be predicted.

The reinforced TFE material, developed by Rogers Corp., is processed in such a way that original glass fiber length is maintained, resulting in good wear resistance and reduced cold flow.

Other uses seen

Self-lubricating characteristics of the bearing point to other types of applications. Bearings have been tested successfully for use at extremely low temperatures and are currently being evaluated for use in hard vacuum environments. The bearings may prove to be a solution in space vehicle applications where maximum reliability must be obtained in extremely difficult environments.

Although the new bearings are more costly than conventional bearings, the simplicity of the method by which they are lubricated could make them highly economical for other uses. Previous high temperature precision bearings have been lubricated by elaborate (and costly) jet lubrication systems which both lubricate and provide a heat transfer vehicle. In such cases, use of a self-lubricating bearing could result in overall cost reduction.



Numbered parts *of pump are described in text.*

Du Pont

Acetal Plastics + Novel Design = More Efficient Gear Pump

$100 AWARD OF MERIT

Paul A. Lee,
Executive Vice President,
Planet Products Corp.,
Chicago, Ill.

■ This gear pump makes use of a unique combination of injection molded acetal plastics and patented mechanical design features. Developed by Planet Products Corp., the pump is highly efficient, yet low in cost.

As a result of its unique design, the pump: 1) requires no lubrication, 2) needs up to 50% less power to operate than other comparable pumps, 3) simplifies replacement of friction parts, 4) can handle a variety of corrosive materials, and 5) is light in weight, reducing shipping costs.

Also significant is the design of the sheave pulley, which eliminates the need for an outrigger to maintain drive shaft alignment, and distributes internal operating stress and strain over large bearing areas without increasing frictional heat buildup. It also maintains alignment of the drive shaft and an even mesh of the drive and idler gears.

Why acetal?

All components of the pump are precision molded in acetal (Du Pont's Delrin) with the exception

of the drive shaft, mechanical seal, o-ring gasketing, a cover plate, studs, and shell bushings.

Acetal was chosen because of its strength, stiffness, creep resistance, corrosion resistance, nonlubricated bearing characteristics, low friction coefficient, dimensional stability, abrasion resistance and excellent fatigue life. All these characteristics are maintained over a range of temperatures and environments.

An additional characteristic of acetal that permitted cost reduction was its moldability to close tolerances. The only machining required was on the drive and idler gears and the bushings assemblies, which were passed through a centerless grinder to insure close fit within the body cavities. Otherwise, all parts were molded to final dimensions.

All parts enclosed

The pump is of a cartridge-type design with all moving and friction parts inside the pump body, the end plates serving as pump covers. This permits use of larger-than-normal bearings and bushings without the increase in friction and consequent heat buildup usually encountered with large bearings and bushings. The larger bearings and bushings make it possible to place 0.040-in. thick metal shells between two acetal surfaces, preventing like materials operating against one another at bearing friction surfaces.

All friction and moving parts are interchangeable, permitting simple replacement. Thus, standard non-wear dimensions of the principal parts of the pump body and end plates can be easily maintained.

Seven acetal parts

The exploded view above shows the components of the pump. The numbered parts below correspond to the numbers in the photo.

1. *Drive gear*, with a bearing boss on both sides, is injection molded of acetal in near-perfect alignment onto the stainless steel driveshaft. Shell bearings, 0.040 in. thick and of any one of several metals specified, are fit onto the acetal bosses.

2. *Large bushings* of acetal fit over the metal shell bearings, providing acetal-metal-acetal bearing contact. Bushings are stationary and fit with close tolerances inside the upper i.d. of the "figure eight" of the pump body.

3. *Idler gear*, molded in acetal, has large bushings molded into the end of the gear. These also turn inside metal shell bearings, which in turn fit inside the lower i.d. of the "figure eight" of the pump body. The ends of the acetal bushings serve also as turning end plates, thereby holding the fluid being pumped in place within the gear teeth cavities for more accurate measure of fluid plus better pressure control.

The shell bearing design intended to separate like materials at the bearing surfaces adds to the life of the pump. Contact between drive gear and the idler gear is not a problem because the fluid being pumped is between the two acetal surfaces.

Planet Products has found that acetal gears provide longer life than metal gears; the plastic's resilience permits foreign or abrasive particles to pass through the gears rather than gouge them.

4. *Front cover* is molded with a precision boss extension. This has a center hole in which is inserted a mechanical seal and through which passes the driveshaft.

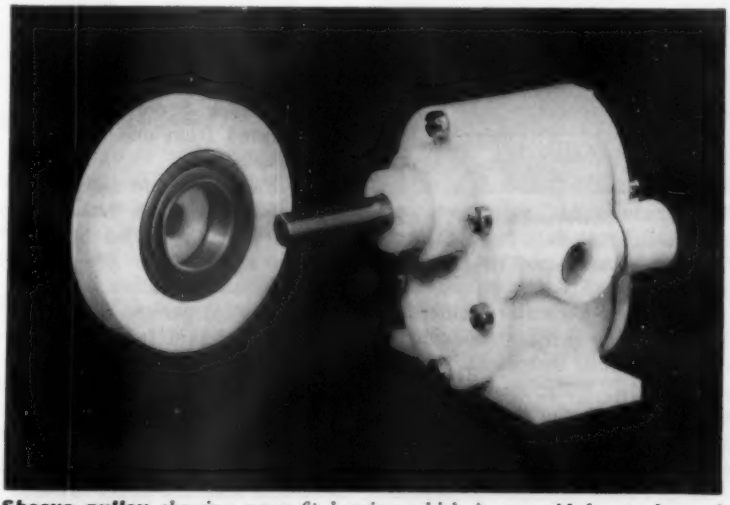
5. *Sheave pulley* is mounted on a ball bearing, the inside race of which fits tightly to the o.d. of the front cover boss. The bearing-loaded sheave pulley is designed to permit the bearing to turn freely on the balls. A tolerance star ring with a resistance hold of 275-300 in.-lb torque holds the sheave pulley on the driveshaft.

6. *Rear cover* is molded with a by-pass cavity and a boss for locating adjustment screw and buttons.

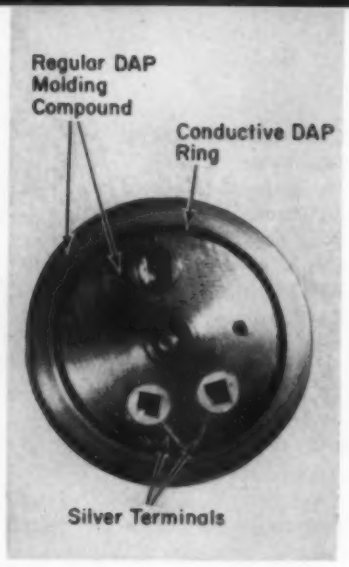
7. *Acetal buttons* separated by a stainless steel spring are activated by an external adjustment screw with locking nut for fixing by-pass pressures.

8. *Cover*, stamped from 0.042-in. thick stainless steel, fits between the acetal rear cover and the pump body. The cover simplifies tooling and manufacturing in producing the bypass channel and the adjustment mechanism.

All pumps are designed so that a stamped stainless steel liner can be included in the molding when required for pumping special types of materials.



***Sheave pulley** showing press-fit bearing which is assembled onto boss of pump body at right.*



Metal wiper *indicated by pencil in cutaway view is riding on a virtually friction-free DAP track. The track is on an insulating DAP base (see right). Housing is cast aluminum.*

DAP Plastic Is Conductor, Insulator in Precision Potentiometer

$100 AWARD OF MERIT

Paul Hines, President,
New England Instrument Co.,
Waltham, Mass.

■ A redesigned potentiometer uses diallyl phthalate for both the resistive element and its insulating base.

The base is a standard mineral-filled compound; the conductive ring is specially compounded with carbon filler. Ring, base and the silver leads to the terminals are all molded into a single part in one operation.

A previous article in M/DE (Dec '60, p 106) described this development and showed pictorially how the molding operation is accomplished.

Better than wire-wound

The new design was developed to eliminate some of the drawbacks of conventional wire-wound potentiometers. Under certain service conditions, wires tended to break. The varnishes and cements sometimes caused performance problems. And jumps occurred in the resistance curve when the wiper moved from one wire coil to the next.

The integral plastic design not only eliminated these drawbacks but also provided added benefits such as lower noise and much higher resistance values. The accompanying comparison chart suggests an important future for the new type of design.

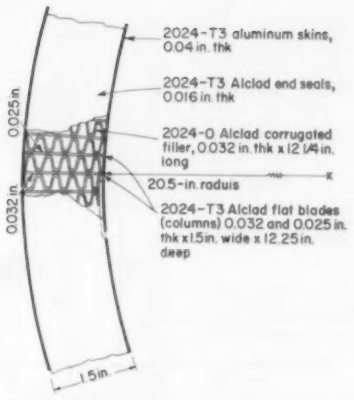
Diallyl phthalate was a logical dielectric to consider for the new design because it maintains its good electrical properties and dimensional stability under adverse humidity and temperature conditions.

	WIRE WOUND	CONDUCTIVE PLASTIC
RES RANGE	50 to 100,000 ohms pract limits	50 ohms to 100 megohms—up to hundreds of megohms
NOISE	Init low at RT, high at low temp. Incr by 1½-2 times or more with rotation	On order of 20-30 mv. Not affected by storage time or low temp svc
LIFE	Ltd by noise, resolution, deterioration, incr linearity tol. Pract limit is ½-1 million rev with 50% deterioration in noise, linearity	Rotation to 100 million rev with no perceptible chg in linearity due to infinite resolution characteristics. Total res incr 5-7%
LINEARITY	Init value for conven ⅛-in. dia pot usually exceeds ±0.3%	Same as molded: 0.25-0.50%. Can improve by mech trimming of track
RESOLUTION	Ltd by wire size, pot dia. To hold ⅛-in. unit to 0.05, wire dia must be much under 1 mil	Infinite
ROTATIONAL SPEED	Avg pract limit 60-100 rpm; special designs to 1000 rpm	Only limited by bearing design. Has exceeded 4000 rpm
TEMP COEF	Adjust by choice of wire alloy. Pract range 20-60 ppm/°C	At pres only 300-400 ppm/°C. New mtls promise lower values
RES TOL	Down to ±1%. Usual range 3-5%	Usual ±10%; can be down to ±1%
POWER RATINGS	Pot 1¼ in. dia normally 2 w at RT down to 0 at 275 F	Std 1⅛-in. pot about same, but mtl will operate at 350 F (new silicones possibly up to 700 F)
TORQUE	With special care in bearing design and low wiper force, can be low as 0.05 oz-in. Friction coef normally 0.2-0.25	Same value can be achieved with same care in bearing design and much higher wiper force. Friction coef about 0.12
MECHANICAL	Mech and elec discontinuity at bridge section can cause wire failure. High probability of single turn of wire failing in use	Cont smooth, glass-like surface for 360 deg. Toroidal elements easily fabricated

Aluminum Shock Absorber Fails, Crushes at Specified Loads

$50 CITATION

Chris Schroeder,
Manufacturing Research Engineer,
Boeing Airplane Co.,
Wichita, Kan.


2024-T3 aluminum skins, 0.04 in. thk
2024-T3 Alclad end seals, 0.016 in. thk
2024-0 Alclad corrugated filler, 0.032 in. thk x 12.14 in. long
20.5-in. radius
2024-T3 Alclad flat blades (columns) 0.032 and 0.025 in. thk x 1.5 in. wide x 12.25 in. deep
0.025 in
0.032 in
1.5 in.

1 Segment *of shock absorber cylinder. Unit is 23.5 in. in dia, 12.25 in. deep.*

■ A unique combination of materials and component configuration is used in a new aircraft shock absorber (Fig 1) that is designed to fail above a given load and then crush within specified limits. The shock absorber is used to protect a large door hinge bearing from the shock and blast of a nearby bomb explosion.

The absorber must withstand a radial load of 350,000 lb with no sign of failure. However, it is required to fail at greater loads ranging from 376,000 to 484,000 lb with the proviso that the load stay within this range even when the structure is crushed radially as much as ½ to ¾ in.

These severe requirements were met by designing the structure with an inner and outer 2024 aluminum skin and using a simple core of corrugated aluminum fillers and flat blades. This design was selected over many other materials and configurations including several types of honeycomb with various plastics foam fillers and even solid molded plastics.

Conventional equipment possible

Aluminum proved to be the ideal material for the shock absorber because of its good combination of light weight, strength, corrosion resistance and low cost. Furthermore, unlike the honeycomb it can be readily blanked, formed, machined and processed with conventional equipment.

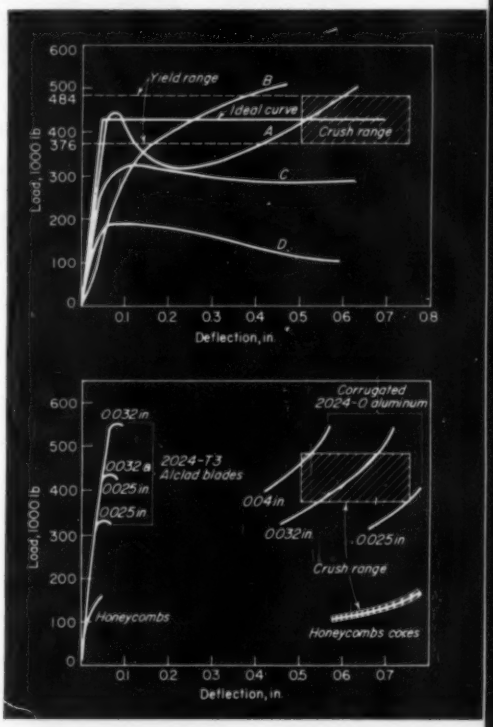
Ideally, the shock absorber load-deflection curve should have a constant slope up to the point of failure and then become a straight horizontal line during crushing. As Fig 2 shows, the new design comes closest to meeting the required curve.

Strength of the shock absorber is controlled by the strength of the material, blade thickness, and arrangement or ratio of thick to thin blades. Crush range is controlled mostly by the thickness of the corrugated fillers (see Fig 3).

Machining minimized

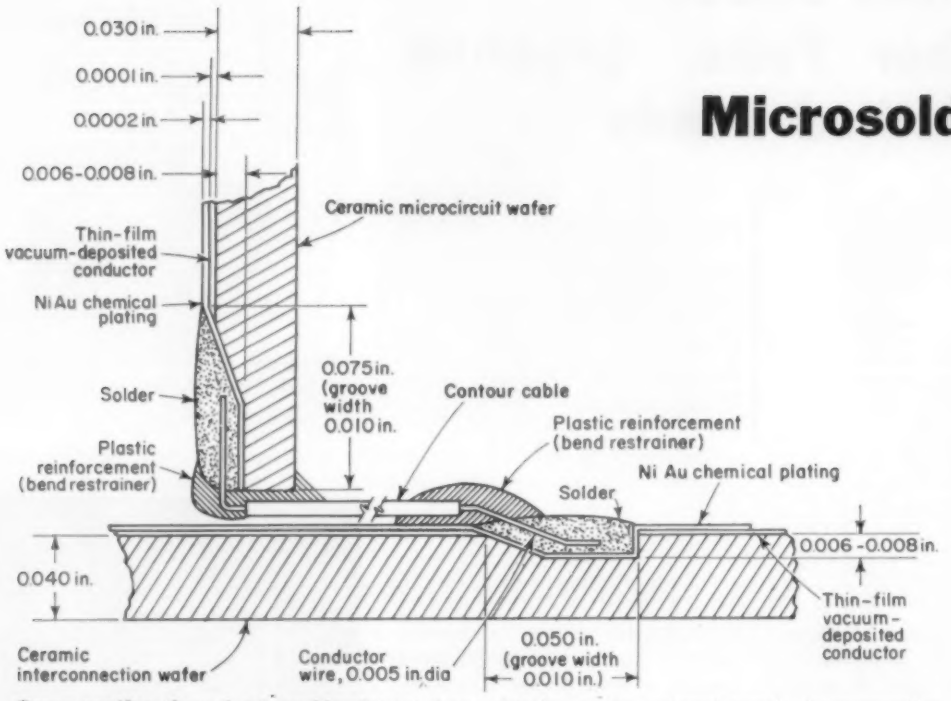
The design is quite flexible in that it can be adjusted to the range of prescribed loads and can be altered to meet an entirely different set of parameters.

Another important feature is that the parts can be bonded with thermosetting adhesive. Thus, final machining is required only to finish the inside diameter to proper dimensions and to square and inset the ends. In contrast, use of honeycomb would have required involved operations to machine to thickness and to roll form into a cylindrical sleeve.



2 Effect of material *and configuration on yield strength and crush range (top). Characteristics close to ideal are provided by aluminum structure consisting of two skins over core of corrugated fillers and flat blades—curve* **A**. *Curve* **B** *represents solid cast sleeve composed of microballoon fillers and a plastic binder;* **C** *a multiwave-type honeycomb core filled with foamed plastic; and* **D** *a plain multiwave-type honeycomb core.* **Effect of thickness** *of material on yield strength and crush range is shown in bottom graph.*

Microsoldering



Cross section *through microsoldered joint shows details of the microelectronic interconnection between the ceramic wafer and the Contour cable.*

$50 CERTIFICATE

G. L. Branch and R. Y. Scapple, Materials and Processes Section, Hughes Aircraft Co., Culver City, Calif.

■ During the past several years a veritable revolution has been taking place in the electronics industry. This revolution, which Hughes calls microelectronics, is also known by other names: microminiaturization, microcircuitry, molecular electronics, molectronics and bionics. One need common to all microelectronic concepts is that all components, devices or assemblies must be electrically interconnected. Hence the significance of a high density assembly developed by Hughes to interconnect the individual substrate wafers of a thin-film computer.

In the Hughes design, the individual wafers are interconnected by means of a short, flat, flexible cable (called Contour cable). The cable mechanically joins the wafers by means of a restraining device and electrically connects them by microsoldered joints. The soldered interconnections are being successfully and reproducibly made at 0.025 to 0.035-in. center-to-center distances. The drawing at left is a detailed cross section of a microsoldered joint.

Two difficult problem areas developed as a result of the interconnection design: selecting suitable materials compatible with design and processing techniques; and handling and fabricating parts in which extremely close dimensions were required between connections.

Seven problems and solutions

1. Wafer material—The substrate material selected for the wafers was a photosensitive glass-ceramic, Fotoceram, produced by Corning Glass Co. Fotoceram was selected for three reasons: its toughness, its chemical inertness, and its thermal shock resistance.

To provide a suitable surface for thin-film deposition, the material is first polished to an optical finish. Final size of the microcircuit wafer is 2 × 3 × 0.030 in.

Compared to soft glass wafers which may easily break during normal handling, the Fotoceram wafers are tough enough to resist breakage when dropped to the floor from table top height.

2. Contour cable—Contour cable is an essential part of the high density interconnection. Either a batch process or a Hughes-designed continuous belt rolling ma-

Interconnects Wafers of Thin-Film Computer

chine can be used to produce a Contour cable with uniformly spaced conductors positioned at a density of 50 conductors per inch (0.020-in. center to center) or greater.

Potential plastics laminating materials include fluorocarbons and vinyls. Polyvinyl chloride with 40 conductors of 0.005-in. dia, spaced 0.035 in. center to center, was used in this design. The polyvinyl chloride combines the greatest flexibility—needed to minimize mechanical strain at the soldered connections—with suitable mechanical and electrical properties.

3. Machining—Ultrasonic machining was used to cut positioning grooves in the wafer to a depth of 0.006-0.008 in. and a width of 0.010-0.012 in. Forty grooves were simultaneously ultrasonically machined lengthwise —parallel to the surface for half their length, and tapering toward the surface for the remaining half. Total machining time was only several minutes per wafer.

4. Metallizing—The ceramic wafers required a solderable and electrically conductive surface. Five metallizing systems were evaluated:

- Vacuum-deposited permalloy and copper, followed by a chemical deposition of gold.
- Vacuum-deposited permalloy and copper, followed by a chemical deposition of gold and nickel.
- Brush-on solderable silver paint.
- Brush-on silver conductive paint with electrodeposited copper.
- Chemically deposited nickel followed by gold.

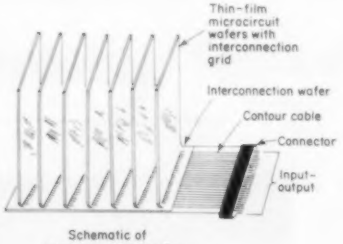
A consistently solderable surface with adequate adhesion was difficult to achieve with the first two systems, partly because of the inability to "throw" evaporated metal onto the groove walls. Consistent surface reproducibility could not be achieved with the solderable silver paint. The last two systems both developed excellent soldering surfaces and showed excellent adhesion to the ceramic substrate. However, the chemically deposited nickel-gold coating was finally chosen because of the close dimensional tolerances required.

To metallize the ceramic wafer, it was first sensitized with stannous and palladium chloride and then plated with electroless nickel to a thickness of 0.000150 in. The entire interconnection area (both within and between the grooves) was plated and the "between groove" plate was later removed by a selective etching technique.

5. Photoetching—A photoresist technique was used to impress a pattern on the ceramic wafer. The interconnection area was first coated with Kodak Photo Resist (KPR). After curing the KPR, a photographic negative was indexed to the wafer and the appropriate pattern exposed. The nonexposed KPR was chemically removed, the remaining material dyed, and the pattern inspected. Unwanted nickel plating was selectively removed with warm ferric chloride. A final etch in dilute nitric acid removed all traces of the stannous and palladium chloride sensitizer. The final steps were to remove the KPR with an organic solvent and microscopically inspect the resultant nickel pattern for adhesion and continuity.

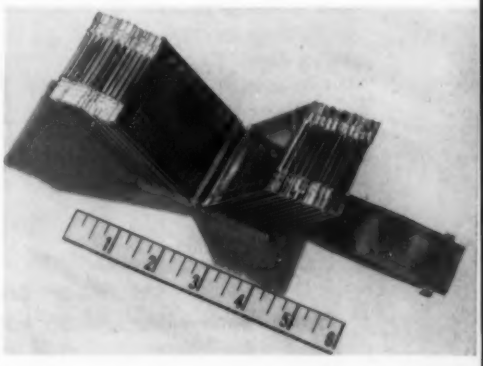
6. Gold plating—Gold plating is used to increase both shelf life and solderability. After photoetching, the wafer was immersion gold plated to a thickness of 0.000006 in. (The immersion gold only deposits on the nickel-plated conductor pattern.)

7. Tinning—Various-sized spheres, pellets, wire and powder of soldering alloy were tried to determine which was best suited for tinning the metallized wafer grooves. Although the preplaced solder forms were all suitable, the most appropriate method proved to be dip soldering. In addition to tinning the metallized surfaces, dip soldering also filled approxi-



Schematic of Interconnection Design

Thin-film *digital computer below has accessible components which open like pages of a book. Above schematic shows computer components.*



mately 75% of the grooves, a necessity for subsequent attachment of the conductor leads.

Design requirements called for a soft solder alloy with high tensile strength, good ductility, high electrical conductivity and low melting temperature. The alloy—25% indium, 37.5% lead, 37.5% tin—was chosen after an extensive testing program because of its comparatively low melting point and good combination of mechanical and physical properties. An activated rosin flux, Kester No. 1544, was selected because of its excellent chemical activity and conformance to government specifications.

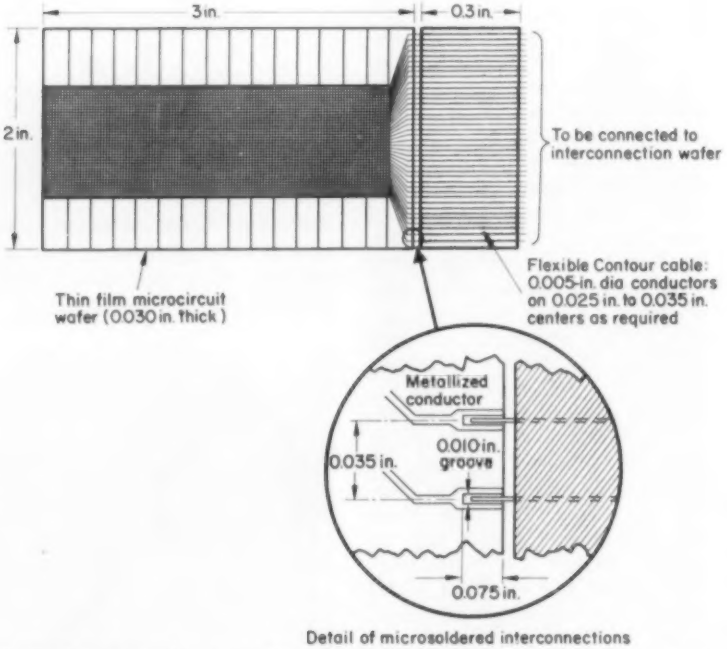
Joining the assembly

Fabricating problems caused by the close dimensions required were solved with the aid of a microscope. The microscope was used for both microsoldering and inspection. Use of the microscope transformed a virtually impossible soldering job into a relatively simple, fast, and nonfatiguing operation. One indication of the simplicity: unskilled operators became proficient in making microsoldered joints after less than 1 hr of instruction.

Various soldering methods, including electrical resistance, conduction and radiation, were evaluated. New joining techniques such as the hot inert-gas method and thermal compression bonding were also considered.

Resistance method chosen—The electrical resistance microsoldering method proved to be the most appropriate for this design for four reasons: it provided high heat concentration, it required a minimum time to melt the solder, the electrode was compatible with design dimensions, and the electrode tip could be used as a positioning or locating tool.

Appropriate electrodes were designed for use with a commercial resistance soldering unit. Nichrome wire was selected as the electrode material because of its high electrical resistance, thermal stability, and resistance to solder wetting.



***Typical wafer-cable** assembly layout. Microcircuit wafer terminates in 40 thin-film conductors spaced on 0.035-in. centers.*

Simple procedure: Five steps are required to make the microsoldered interconnections:

1. Pre-place the previously tinned conductor wires in the tinned grooves of the ceramic wafer and apply an activated rosin flux with a small brush.
2. Place the resistance soldering electrode on the conductor wire and apply current for 1-2 sec. Use of an automatic timer on the resistance soldering transformer is important because heat is applied only when required and the electrode is used as a positioning tool while the solder solidifies.
3. Hold electrode on the wire until soldification occurs.
4. After soldering, remove the flux residue from the wafer and Contour cable with suitable solvents.
5. Apply a modified epoxy resin between the Contour cable and wafer to serve as a bend restrainer (see drawing, p 142). The restrainer prevents flexing and fatigue stress from developing at the solder connection or in the heat affected zone of the conductor wire.

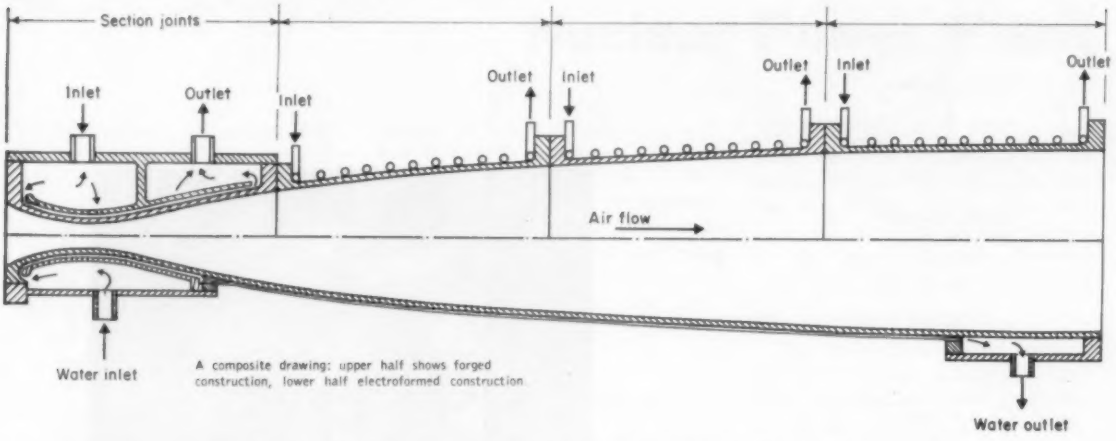
Joints thoroughly tested

Tensile, peel and flexure strength tests were performed to determine mechanical strength and reproducibility of soldered interconnections. Test results can be briefly summarized:

- All tensile failures occurred in the wire adjacent to the solder connection. No failures developed in the solder joint itself.
- Peel test failures occurred at the wire–solder interface, not at the coating–wafer interface.
- Flexure tests of interconnections reinforced with the resin bend restrainer revealed that flexing occurred only in the Contour cable and not at the joint. No failures were encountered in the joint itself.

The last test indicates a high degree of reliability in the computer. Flexure occurs only during assembly or maintenance, and the stress level at these times is lower than that developed during testing.

Multi-Piece Forged *ADVANTAGES: Small sections can readily be bored; any region can be replaced separately. DISADVANTAGES: Expensive forgings of nickel required prior to machining; interrupted contours on inside of nozzle may cause potential expansion waves and therefore poor quality of air flow; extensive hand finishing usually required to blend contours; longitudinal thermal gradients may cause poor air flow; cooling arrangements complex.*



A composite drawing: upper half shows forged construction, lower half electroformed construction

One-Piece Electroformed *ADVANTAGES: Clean interior surfaces; minimum longitudinal temperature gradients; nozzles can be duplicated with minimum of effort and cost. DISADVANTAGES: Replacement of any region may require whole new nozzle.*

Large Wind Nozzles Made by Electroforming Nickel

■ Large, one-piece nickel nozzles for use in a wind tunnel simulating Mach 6, 8 and 10 air flows have been produced successfully by electrolytically depositing nickel on a conductive pattern. The resultant parts, ⅝ in. thick, conform atomically to the shape and surface of the pattern.

$50 CITATION

G. E. Sutila and
J. F. Goodwin,
Aerophysics Laboratory,
Douglas Aircraft Co., Inc.,
El Segundo, Calif.

Why electroforming?

Electroforming was used because it produces a nozzle to close tolerances having smooth internal surfaces. If the nozzles had been in one piece from a large nickel forging, they would have required difficult and tedious boring operations. And if the nozzles had been made by bolting machined nickel forgings together, they would have required a more complex cooling arrangement.

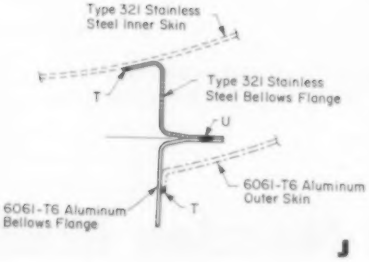
The one-piece electroformed nickel nozzles are said to generate a high quality air flow at their exits. A compressed air supply of 3500 psi heated to a maximum of 2200 F is used as the motive air source. The nozzles are water cooled because of high heat transfer rates inherent in the design.

Close tolerances held

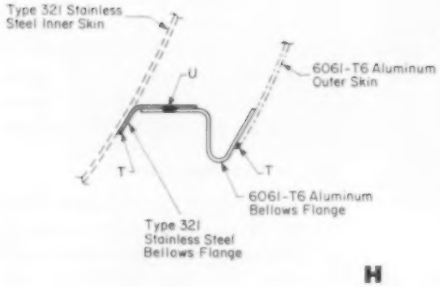
The Mach 6 nozzle, measuring 11 ft, 11 in. long, was formed on a machined, two-piece aluminum mandrel that was accurately contoured. It was finished to 16-32 μin. Radial tolerances were ±0.001 in. at each of 1440 check points. The Mach 8 and 10 nozzles were formed on a two-piece mandrel contoured and finished like the Mach 6 nozzle. The first 35 in. of the Mach 8 and 10 mandrels were made of machined beryllium copper and the remainder of machined aluminum. The Mach 8 nozzle is more than 13 ft long and the Mach 10 almost 16 ft long.

Ultrasonic Welding

I



J



H

***SNAP-1A* generator.** *A—atomic fuel capsule; B—supporting tubular members; C—load members; D—thermoelectric elements; E—type 321 stainless inner skin; F—6061-T6 aluminum outer skin; G—water coolant coil; H—large bellows subassembly; I—medium bellows subassembly; J—small bellows subassembly. Details of joints H, I, and J are considerably enlarged. Letter U indicates ultrasonic spotwelds; T—indicates TIG-welded joints.*

$50 CERTIFICATE

J. Koziarski, Denver Div., The Martin Co., Denver, Colo. and P. Dick, Nuclear Div., The Martin Co., Baltimore, Md.

■ "Impossible" welds are an integral part of the design of SNAP-1A (System for Nuclear Auxiliary Power), a portable power plant that directly converts nuclear to electrical energy for space applications.

As the cutaway photo shows, an integral double shell containing thermoelectric elements (D) encases the converter. The inner skin (E), formed from type 321 stainless steel, serves as the hot junction, and the outer skin (F) of 6061-T6 aluminum alloy acts as the cold junction.

Six bellows (H, I, J) serve as flexible joining subassemblies between the stainless and aluminum skins, providing a means of differential contraction and expansion. Between the two shells a

Joins Stainless to Aluminum in Nuclear Power Plant

reducing mixture of argon and hydrogen gas is maintained at 1 atm pressure to protect the thermoelements from oxidation or sublimation. Thus the joints between the inner and outer skins must be hermetically tight.

The bellows are made of stainless and aluminum so that similar metals can be welded at the shell junctions. But stainless and aluminum must be welded together to form the bellows themselves.

Ultrasonic welding the key

Both type 321 stainless and 6061-T6 aluminum have excellent weldability to themselves. There is no known conventional method, however, by which they can be fusion welded to each other. Soldered joints can be made, but the requirement for a hermetically-tight seal as well as good joint strength precluded their use.

Without ultrasonic welding, it would not have been possible to produce the required joints. Ultrasonically welded, the subassemblies withstand 30 to 40 psi gage air pressure and 1 atm helium pressure without leaking.

Skin requirements severe

The entire SNAP-1A system must withstand heavy shock, vibration and acceleration loads during rocket-boosted launching without system failure. In addition the . . .

Internal skin must withstand a temperature of 1050 F without corroding or oxidizing; withstand mercury attack up to 600 F; resist radiation attack resulting in unacceptable embrittlement; resist corrosion when on the ground; and be strong enough to support 4000 lb of mercury during ground handling operations and the weight of the thermoelectric system during launching.

External skin must not be unduly affected by 330 F operational temperature; resist corrosion and oxidation; provide good heat conductivity; combine structural stability with low weight; and provide shielding against micrometeorite impact.

Stainless, aluminum chosen

Type 321 stainless steel was chosen for the internal and 6061-T6 aluminum alloy for the external skin.

The 321 grade of stainless was selected because it has good weldability and is not sensitive to carbide precipitation during welding. Consequently the weld heat-affected zone will not be sensitive to intergranular corrosion when the converter is stored on the ground without nuclear fuel. When the generator is fueled and on the ground, the temperature of the inner skin will not be higher than 600 F; at this temperature mercury does not attack 321 stainless. In addition, type 321 stainless steel provides effective resistance to oxidation up to about 1700 F. Good formability plus sufficient tensile strength at room temperature (75,000 psi) to sustain the load of 4000 lb of mercury when on the ground were also selection factors. At the actual operating temperature of 1050 F, strength is relatively good (about 13,000 psi for 1% creep in 10,000 hr).

The 6061-T6 aluminum alloy was selected because of its effective resistance to corrosion in natural environments and to oxidation at elevated temperatures. It has good formability, and relatively good tensile strength (about 30,000 psi) at the operational temperature of 335 F. The very good heat conductivity and high specific heat of the aluminum keep the temperature of the outer skin uniform. As a result the voltage of the thermoelectric elements stays relatively constant.

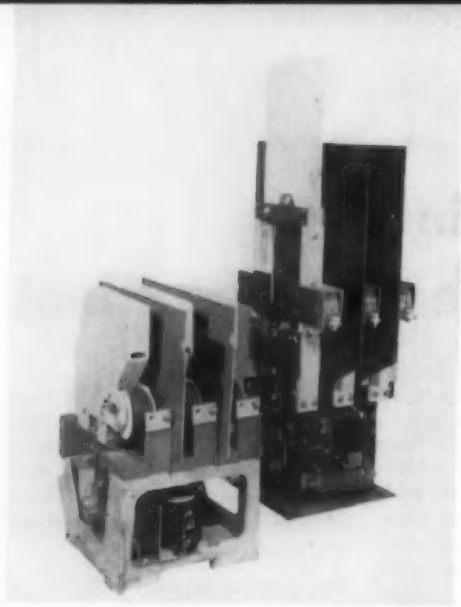
The welding process

The photo shows cross sections of the three types of welded joints used. Interleaving the stainless-aluminum joints with 1145-H18 aluminum foil 0.015 in. thick allowed the joints to be made more easily and increased joint consistency.

Careful attention was paid to preparation of detail parts and the establishment of welding parameters in order to insure joint reliability. The aim of the welding program was to obtain a hermetically tight joint; maximum strength was a secondary consideration. However, because ultrasonic welding results in minimum degradation of mechanical properties, tensile-shear strength of test specimens was about 1300 lb per linear inch—close to the required minimum tensile strength of 42,000 psi for 6061-T6 sheet.

Stainless steel details were degreased and pickled, and the pickling smut removed with fine emery paper just before welding. Aluminum details were degreased, deoxidized and cleaned with fine stainless steel wool before welding. All edges were deburred in the longitudinal direction to prevent crack formation.

Welds were performed on a 4000-w spotwelder with 18 to 20 overlapping spots per linear inch. (The large bellows, H, for example, contains about 1100 overlapping spot welds.) Pertinent welding parameters: clamping force, 600 lb; time interval, 0.75 sec; power, about 1700 w.



Glass-Polyester Reduces Size of High Voltage Equipment

NEW **OLD**

Completely redesigned *contactor (left), made possible through use of a special glass-polyester insulating material, permitted 50% reduction in size of high voltage motor control equipment.*

$50 CITATION

Thad F. Bellinger,
Senior Engineer,
and Lawrence A. Burton,
Development Engineer,
Allis-Chalmers Mfg. Co.,
Milwaukee, Wis.

■ A change in insulating materials has made possible the development of high voltage motor control equipment that boasts lower installation costs, simplified maintenance, improved safety and convenience and, especially, considerably reduced size.

Specifications for the project called for the design of "a new 400-amp, 2000-5000-v unit with an interrupting rating of 50,000 kva that could be packaged in one-half the space required by existing designs."

Contactor redesigned

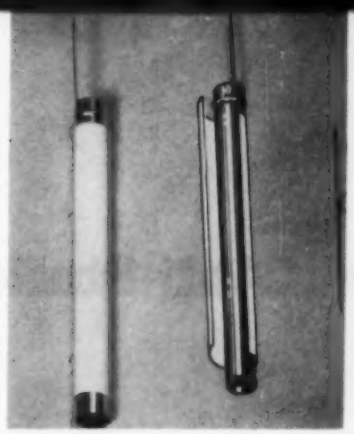
In order to reduce the size of the unit, it was essential to redesign the high voltage main power line switch, or contactor (see accompanying photo). The contactor, in turn, could be scaled down only if an improved insulating material could be found to compensate for the more stringent requirements involved. The redesign was made possible through the use of a special glass-reinforced polyester insulating material having flame retardant and arc-track resistant characteristics.

The special characteristics of the new material permitted the incorporation of arc interruption phenomena and mechanical construction that would have been impossible with the insulating materials previously used, i.e., porcelain, phenolics, impregnated woods and conventional glass-polyesters. For example, the new glass-polyester material provides greater resistance to mechanical and thermal shock than does porcelain; it has better mechanical strength and fabricability than any of the materials previously used; and it offers carbon tracking resistance 100 to 200 times greater than that of standard glass-polyester formulations, and up to 1000 times greater than that of phenolic materials.

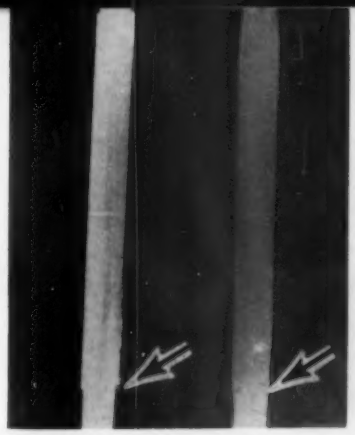
The improved insulating material, which consists of basic polyester ingredients compounded with an aluminum oxide compound ($Al_2O_3 \cdot 3H_2O$), is used throughout the contactor and carriage assembly, and in stationary structures of the controller compartment. It is also used for direct support of live high voltage circuit components and in areas where normal arc exposure is expected.

Now units can be stacked

Test results on the new contactor indicate that the design meets all requirements of AIEE and NEMA standards covering equipment of this type. Moreover, the new units are approximately one-third smaller than the smallest equivalent units now available, and up to three-fourths smaller than the largest equivalent units now being used. As a result, two complete units are now stacked, one above the other, in the same space previously required for one unit.



1 Cathodes are made *by wrapping pre-cast coating around nickel base and bonding in place.*



2 Old vs new *cathode. Note sharp edges on wrap-around coating (left), feathered edges on sprayed coating (right).*

3 Uniformity *of Sarong cathode (left) shows much less variation than sprayed cathode (right) at* 1475 *F.*

Pre-Cast Emissive Coating Improves Tube Cathodes

$50 CITATION

D. R. Kerstetter,
Materials Engineering Dept.,
Electronic Tube Div.,
Sylvania Products, Inc.,
Emporium, Pa.

■ A new method has been developed for coating the nickel sleeve of receiving tube cathodes with a precisely controlled mixture of barium, strontium and calcium carbonates. The emissive coating is pre-cast as a film which is then wrapped around and bonded to the cathode sleeve (Fig 1). The new cathode (it is called a Sarong cathode because of its shape) has greatly improved tube performance by:

- Lowering overall dispersion levels of plate current, transconductance and amplification.
- Lowering noise level.
- Providing better cutoff characteristics.
- Increasing tube life.
- Improving the uniformity of the product.

Until recently the most common method of applying the emissive coatings was to spray them on to the nickel cathode. Spraying is accomplished by mounting the cathode sleeve in a rack or mask so that only a selected area is covered with the carbonate mixture. This method tends to produce undesirable feathering of the cathode at each end. As shown in Fig 2, the ends of the sprayed coating gradually taper off; in contrast the Sarong cathode has very sharp, clean edges at the ends of the coating band.

Although Sylvania is still using the spray method, it is being rapidly replaced by the superior Sarong coating process.

How Sarong coating improves . . . performance

For proprietary reasons Sylvania will not give details on the Sarong process itself. However, the improvement in performance is indicated by Fig 3 which shows how the old and new cathodes look when operating at 1475 F. Note that, in comparison to the sprayed cathode, the Sarong cathode exhibits a much more uniform temperature and is almost completely free of isolated hot spots (both cathodes have the same density).

. . . uniformity

The improvement in performance described above is obtained because the Sarong coating has a very uniform texture, in contrast to the sprayed coating which contains many voids and variations in density. The Sarong coating is produced to a thickness tolerance of ±0.00005 in., whereas the best possible spray tolerance is ±0.0005 in. This improvement is extremely important in manufacturing receiving tubes because the space from grid to cathode is often as small as 0.001 in. Also, the density of the Sarong coating can be held to ±2%, in comparison to ±10% for the sprayed coating. Finally, the total weight variation of the Sarong coating can be maintained at ±0.25% compared to ±10% for the sprayed cathode.

. . . manufacturing

Another important feature of the new process is that it lends itself to completely automatic production. The new cathodes can be made more quickly than the old ones. Production of sprayed cathodes can be automated, too, but studies show that production rates would actually be lower than for the batch spraying method which is used at present.

ADF Sense Antenna, *shown by arrow, must have a coating that will provide anti-static properties, withstand very severe environments and stand up to diester lubricants used in gas turbine engine.*

Catalyzed epoxy coating, *carefully applied in cross-sprayed layers, is uniform in thickness and thus in dielectric properties.*

$50 CITATION

R. F. Howard,
Materials & Processes
Group Engineer,
Bell Helicopter Co.,
Ft. Worth, Tex.

Anti-Static

■ A new anti-static epoxy coating has been developed for aircraft antennas. Unlike previously used rubber-type coatings, it has high resistance to diester synthetic oils. These oils, though having excellent lubricating properties, are death to most organic materials, especially coatings.

Why a new coating was needed

Bell engineers first realized that they had a problem during desert tests of their new Army H-40 (Iroquois) turbine-powered helicopter. To comply with military specifications the antenna was coated with a standard neoprene rubber anti-static coating (MIL-C-7439B, USAF, Class 2). This semiconductive coating is designed to provide better radio reception by transmitting static back to the helicopter and by preventing precipitation static from discharging to the atmosphere.

Unfortunately, the rubber-type coating in the military specification cannot resist diester lubricating oils—widely used in the Iroquois gas turbine engine. After desert tests (at temperatures up to 140 F) the coating completely separated from the antenna surface, except for a small area which could be easily removed, much like a strippable coating.

Early formulations failed

Soon after the failure was reported, rubber manufacturers made several attempts to develop an improved neoprene coating that would resist diester lubricants. However, none of the coatings proved successful.

Subsequently, because the antenna shell is made of a plastic laminate, designers decided to

Antenna Coating Resists Diester Lubricants

provide a gel coat layer on the antenna at the time of wet layup. This gel coat was impregnated with finely ground carbon black for conduction. Early tests on the coating showed that it had the required dielectric properties—the average of resistances from various locations was required to fall within a range of 0.5 to 15 megohms. Unfortunately, however, this range could not be held because the thickness (which determines dielectric properties) of the coating could not be closely controlled.

Catalyzed epoxy coating best

Many other attempts to develop a suitable formulation were made, many of which proved unsuccessful because the carbon black tended to precipitate out after the mixture was sprayed and cured. However, a breakthrough was made with the development of a particular conductive carbon which was found to work well in a catalyzed epoxy paint. This paint proved to have excellent resistance to diester turbine oils at temperatures up to 500 F. It is now being used on the antenna and, because of its excellent properties, is creating much interest in the aircraft electronics industry as an anti-static coating for nonconductive radio and radar shells. Here is a summary of its important properties:

Dielectric properties—A notable shortcoming of the previously used rubber-type coating was its inability to hold specified dielectric properties. Standard tests in a Weather-Ometer showed that dielectric properties would stay within a range of 0.5 to 15 megohms for only one day. Similarly, required properties could not be held for more than one week during normal outdoor exposure in Texas.

In contrast, the new catalyzed epoxy coating has kept its dielectric properties after more than one year of outdoor exposure. Because of the nature of catalyzed epoxies, the sunlight and ultraviolet light produced some slight surface chalking or powdering. Even after removal of erosion products, however, the coating retained its dielectric properties.

Rain and particle erosion resistance—Tests conducted on the leading edges of tail rotor blades show in rain erosion resistance, the new epoxy coating does not perform as well as the rubber coating at 500 mph—the rain erosion speed required by the government specification.

Similarly, because of its higher hardness the catalyzed epoxy coating is not as resistant as the softer rubber-type coating to impingement by sand, hail and dust at normal operating temperatures, i.e., 10 to 200 F. However, the rain erosion and particle resistance of the coating is adequate for the speeds and ground conditions that are encountered in actual use with subsonic aircraft.

High and low temperature resistance—The new epoxy coating has shown excellent stability when exposed to 500 F for as long as 24 hr. In contrast, the rubber-type coating is stable for only 2 hr at 300 F, begins to blister at 320 F, and is essentially destroyed within 10 min at 400 F.

The epoxy coating is superior at low temperatures as well. In impact tests conducted at –50 F (using a ball peen hammer) the epoxy coating was essentially unaffected; however, the rubber-type coating shattered and actually flaked off. This test was considered to indicate how the coating would behave when subjected to hail or ice formations which are often encountered at high altitudes.

How the coating is applied

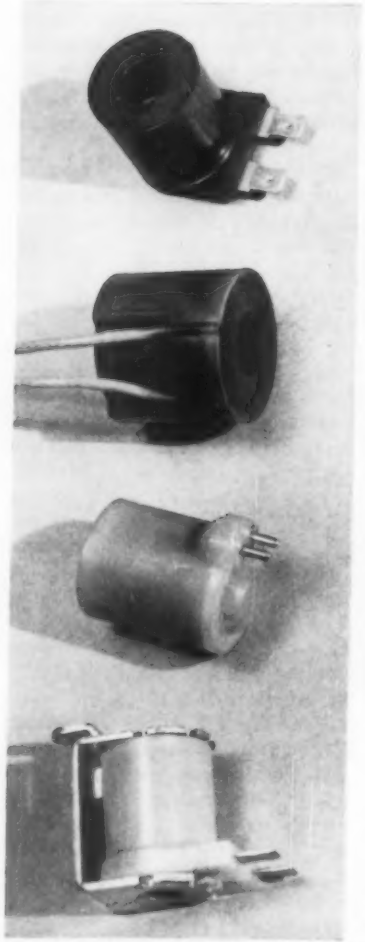
Surface preparation and application can have an important effect on properties of the epoxy coatings. Thus, considerable care is required.

Because the reinforced plastic antenna normally has a glazed finish and may have residual parting agent, the surface has to be degreased, washed in detergent and thoroughly sanded. Briefly, the coating is applied by: 1) horizontally or vertically spraying one coat; 2) making an immediate second pass in the opposite direction across the wet coat; 3) making three additional applications the same as in step 1, allowing 10 min for solvent flash-off between each cross coat application; 4) drying for 4 to 6 hr; and 5) curing for 24 hr at 140 F, or any other suitable combination of time and temperature.

Coatings applied by the above process will be 3 to 3.5 mils thick and have a surface resistance of 0.5 to 15 megohms. Any appreciable change in the application time between cross coats or in the number of cross coats will result in failure to produce the range of dielectric properties required for an antenna anti-static coating.

If a different range of properties is needed, it can be readily obtained by altering the formulation, reducing the number of cross coats, altering the drying time between coats, or altering the cure cycle.

Coils Encapsulated by Injection Molding Nylon



Versatility, *better protection, colorability and improved appearance result from nylon encapsulation of coils.*

$50 CITATION

E. H. Anderson and
C. F. Heidorn,
Anderson Controls, Inc.,
Franklin Park, Ill.

■ Encapsulation of electrical magnet coils by injection molding of nylon provides greater versatility of shape and color, better protection from adverse environments, and better appearance than conventional tape-wrapped, varnish-impregnated constructions. Also, cost can be substantially lower when volume production permits use of multicavity molds.

Eight benefits gained

Developed by Anderson Controls, Inc., the coils offer the following benefits:

1. Flexibility and impact strength, which eliminate production rejects due to thermal and physical shock.
2. Opportunity to incorporate mounting pads not available in coils protected by brittle coatings.
3. Low friction and good wear resistance—useful for applications where the encapsulant also serves as a bearing surface, e.g., solenoids and contactors.
4. Good resistance to high and low temperatures within the limits of AIEE 220 F (formerly Class A) rating.
5. Good resistance to humidity.
6. High resistance to certain acids, alkalis, detergents and oils.
7. Excellent dielectric strength in relatively thin sections, particularly important where space is critical.
8. Availability in a wide variety of colors.

Comparative evaluation made

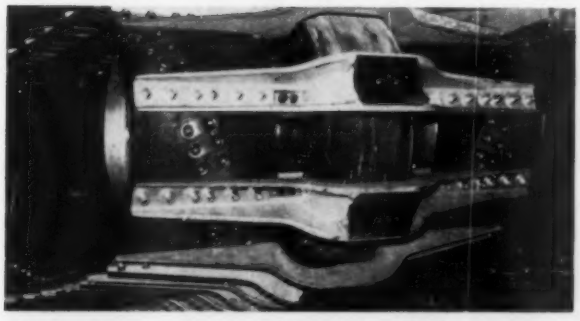
Dole Valve Co. compared the performance of a nylon-encapsulated coil with that of a "can" type integral solenoid coil presently used on water valves for commercial clothes washers. It found the nylon-encapsulated coil was comparable to the conventional construction in 1) electrical characteristics, 2) opening voltage performance, 3) temperature rise during operation, 4) terminal pull-out strength, and 5) operating life under normal conditions.

Nylon-encapsulated coils provided substantially superior results in tests for:

1. *Life cycle under splashing conditions*—Under splash conditions in 200 F water, all nylon-encapsulated coils were still functioning properly after about 64,000 cycles. Of four conventional constructions, one was still functioning after 64,000 cycles; three failed by shorting-out after cycling for periods of 30,000 to 50,000 cycles.

2. *Cold water immersion*—Coils were immersed in 50 F water for specific periods of time, removed and tested for insulation breakdown or current leakage. All nylon-insulated coils withstood satisfactorily immersion times up to 68 hr. Of conventional constructions, 50% failed after 1 hr; all had failed at the end of 3 hr.

Terrapin *is first operational tracked vehicle to use a forged aluminum grouser bar.*



Track *of new vehicle consists of forged aluminum bars mounted to fabric-reinforced rubber belting.*

Forged Aluminum Track Bar Cuts Weight, Costs Less

$50 CITATION

Clifford J. Nuttall, Jr. and Engineering Group, Wilson, Nuttall, Raimond Engineers, Inc., Chestertown, Md.

■ The track bar shown in the closeup view of the Terrapin would have weighed 26 lb and cost more than $20 if made in cast steel. Forged in aluminum alloy 2024-T6, it weighs only 6.25 lb and costs only $13.50.

The Terrapin is a working vehicle to be used in the Army's mobility research programs. Having recently completed acceptance tests, it is the first joint-articulated tracked vehicle capable of traversing all terrains, including marshes, soft snow and water. It is also the first operational tracked vehicle to use a forged aluminum grouser bar, though similar designs are under development.

Forging design

The grouser bar needs good resistance to impact, since the vehicle can travel cross country at speeds greater than 30 mph. It must also have good fatigue life, since it is constantly flexed and low frequency vibrations are generated as the road wheels roll across it.

The 36-in. long forging was designed on the basis of 7500-lb load at the center of a 33-in. span. The load value represents one-fourth of the weight of a single unit of the vehicle plus 2 g's acceleration force. When tested, the forged bars withstood a 11,000-lb load at mid-span without permanent deformation.

The forgings were made by the Halethorpe, Md., works of Kaiser Aluminum and Chemical Corp.

The track bar has two extruded aluminum drive lugs on its upper surface. These are covered with ¼-in. urethane elastomer pads to provide a cushioned engagement with the sprocket teeth.

On the bottom of the track bar is a formed aluminum pan which carries a heavy urethane road pad (see photo). This pad keeps the aluminum bar from making direct contact with hard surfaces and protects paved highways from marking.

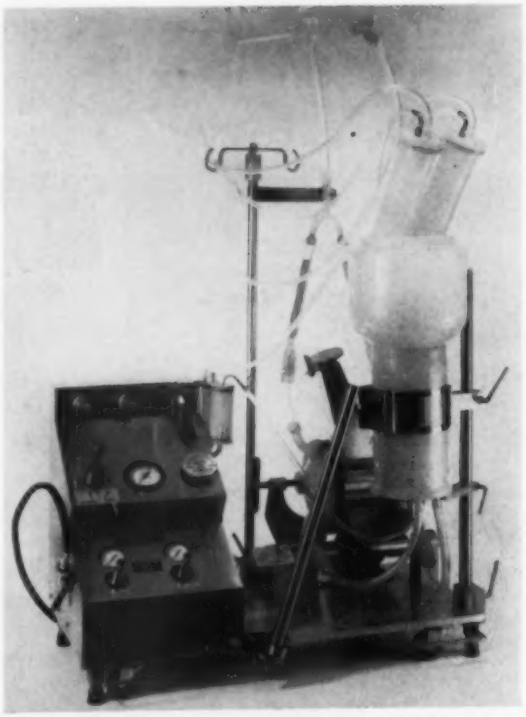
Switch to Polypropylene Improves Heart-Lung Machine

$50 CITATION
Hazen F. Everett, Engineer,
The Foregger Co., Inc.,
Roslyn Heights, N. Y.

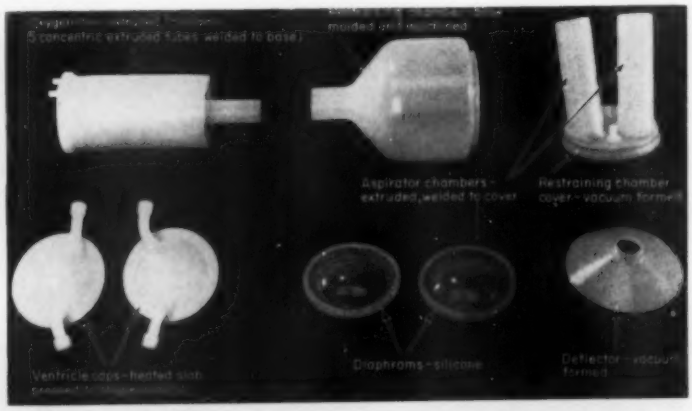
■ Improved performance, reduced weight, increased strength, longer life, and greater resiliency are the reasons given for the selection of polypropylene for blood handling components in a heart-lung apparatus.

Specifications called for the blood handling components to be: 1) physiologically inert; 2) able to withstand repeated autoclaving at temperatures up to 260 F, and to retain size and shape under exposures to steam; 3) transparent or transluscent; 4) lightweight; 5) strong and tough; 6) good heat insulators; 7) easily extruded and formed; and 8) joined with mating edges and surfaces perfectly sealed and permanently bonded without use of toxic substances.

Previously used materials included glass, high density polyethylene, polycarbonate and methyl methacrylate plastics, and stainless steel, each of which presented problems in one or more of the specifications. The decision to use polypropylene was based on a literature search for a material that would stand up better under the severe requirements listed above. All opaque materials were immediately rejected. Polypropylene was selected because it not only appeared to satisfy all of the requirements, but seemed to offer superior performance and longer life. This has actually proved to be the case.



Blood handling components *(right) of heart-lung apparatus are made exclusively of polypropylene.*


5 concentric extruded tubes welded to base
molded cap
Aspirator chambers - extruded, welded to cover
Restraining chamber cover - vacuum formed
Ventricle caps - heated slab
Diaphragms - silicone
Deflector - vacuum formed

Various forming methods *were used to produce polypropylene parts.*

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first in silicones

Dow Corning

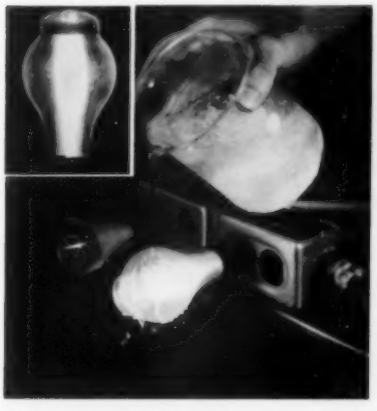
SILICONE NEWS

for design and development engineers • No. 83

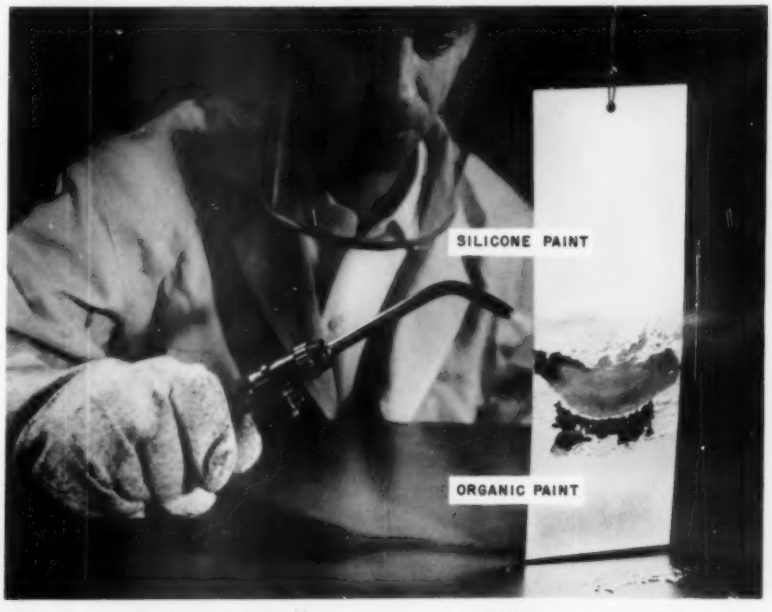
SHATTERPROOFED WITH SILICONES

One of the most common safety hazards — exploding light bulbs — has been overcome in a new incandescent lamp through the use of silicone adhesives and glass yarns.

Developed and marketed by Duro-Test Corporation, North Bergen, New Jersey, the new lamp — named "Flamescent" — is truly shatterproof. It can be dropped onto a hard surface without exploding into a shower of glass. While in use (and hot) it can be dipped in ice water without danger of flying glass fragments.



Unique application of new *and* old materials gives the lamp this safety-glass ruggedness. The bulb consists of a glass shape wound with *(Cont. pg. 2)*



New Finish For Hot Spots

Metal products of all descriptions can now be made to stay new looking longer even when subjected to hot operating temperatures or to the deteriorating effects of weathering. How? By using protective coatings and finishes formulated with Dow Corning silicone resins.

Colored product finishes based on these semi-inorganic resins won't crack or blister even up to temperatures as high as 600 F. Gloss and color are retained even though constantly exposed to sunlight or corrosive atmospheres. Result — longer life, and increased customer satisfaction.

New silicone-alkyd baking enamels combine ease of application with flexibility and toughness. Using these enamels, it's frequently practical to paint-before-forming metal parts. Baking cycles are consistent with standard painting practices.

Full range of colors, too. Silicone-based paints can be pigmented almost any hue.

Available now from many paint manufacturers, silicone-based paints could help make important changes in your quality and profit picture. For more information and names of suppliers, circle . . **No. 242**

Paint based on new Dow Corning resin takes a 180° bend on a ¼" mandrel without crazing, checking, or peeling.

Reproduces Fine Detail

The making of what are believed to be the most accurate models of the moon in existence today was given a big boost by Silastic® RTV, the fluid silicone rubber that cures at room temperature.

By pouring Silastic RTV over his original, painstakingly constructed model, Mr. William Benton, "the moon man", obtained flexible and dimensionally stable molds that perfectly duplicate the extremely fine details of the original. Polyester resins are cast in the RTV molds to make more of these accurate moon models.

Silastic RTV is easy to use. Simply mix it with a catalyst and pour. The mix flows freely, filling every hairline. After a few hours at *room temperature*, you have a flexible silicone rubber mold that strips readily. You're ready to start casting!

Reproduction: Benton model of the moon

Flexible molds for producing prototype parts in plaster, plastics, waxes or low melt alloys are quick and inexpensive with Silastic RTV. Circle . . . . . **No. 241**

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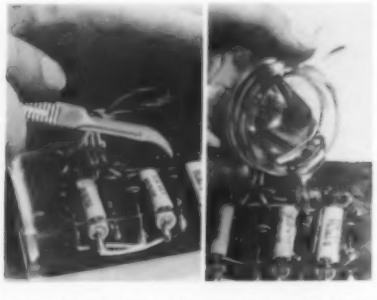
MORE

WANTED: CREATIVE ENGINEERS

...to investigate a unique new silicone resin that cures to form a tough, transparent mass. Named Sylgard® 182, this new solventless silicone resin is supplied as an almost colorless liquid. After blending with its curing agent, it's a simple matter to pour it in place.



Even in totally confined enclosures, Sylgard 182 cures to a flexible and transparent material having outstanding dielectric properties and good moisture resistance from —100 to 400 F. On the Shore A Scale, hardness of Sylgard 182 is approximately 40; elongation is in the range of 100%. Tensile strength is in the range of 800 to 1000 psi.

Curing time for Sylgard 182 Resin can be varied by changing the curing temperature. At 150 C, it cures in 15 minutes; at 65 C, four hours; at 25 C, three days. Neither the resin nor its curing agent is toxic to the skin. No toxic fumes are given off during mixing or curing.

⇦ Electronic components and circuits encapsulated in Sylgard 182 Resin are clearly visible, simplifying replacement or repair procedures. The cured resin can be cut away with a sharp knife to permit repair or replacement of defective components. New resin poured over the repaired area adheres to the existing cured material, restoring the encapsulant to the original condition.

Keep in mind that while this new material exhibits some rubber-like properties, it is a solventless silicone resin, not a rubber. For more data and information about Sylgard 182, circle . . . . . *No. 243*

new literature on silicones

Silicones in Appliances can give that extra edge for extra sales. This colorful booklet tells where and how silicones are being designed into appliances to give more efficient and reliable performance. Illustrations show how planning around silicones can make good products better. *No. 245*

Space Age Silicones are described in thirty typical application stories. Utilization of silicone compounds, fluids, lubricants, protective coatings, rubbers, resins, potting materials and sealants are illustrated for your consideration. This valuable brochure offers solutions to many problems encountered in designing space age aircraft and ground support equipment. *No. 246*

You And The Silicones — a 30-minute, full color movie lets you see silicones in action. It's an all-encompassing, dramatic documentation of designers' adaptations of these versatile engineering materials in different applications. For information about arranging for a free showing, request . . . . . *No. 247*

LIGHT BULB *(Continued)*

Fiberglas yarn. The glass and yarn are bonded into a single unit with a rubbery Dow Corning silicone adhesive. Several materials were tested but only the silicone adhesive remained transparent and resilient despite long, continuous exposure to the heat of the lamp.

While the Flamescent derives its name from the warm, flame-like glow it casts, its lumen output is actually higher than that of any other processed bulb. It is a glareless bulb and lasts at least 3 times longer than conventional lamps..

Available in standard sizes, the Flamescent with its weatherproof features is ideal for yard and outside display lighting. Duro-Test also recommends the new bulb for use in all types of industrial and commercial fixtures where the bulb may come in contact with flying sparks, welding slag, hot solder, water, and many other attacking conditions. *No. 244*

Dow Corning Corporation, Dept. 5317, Midland, Michigan
Please send me: 241 242 243 244 245 246 247

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Electrical Resistivity of 43 Metals and Alloys*

*Microhm-cm at 68 F

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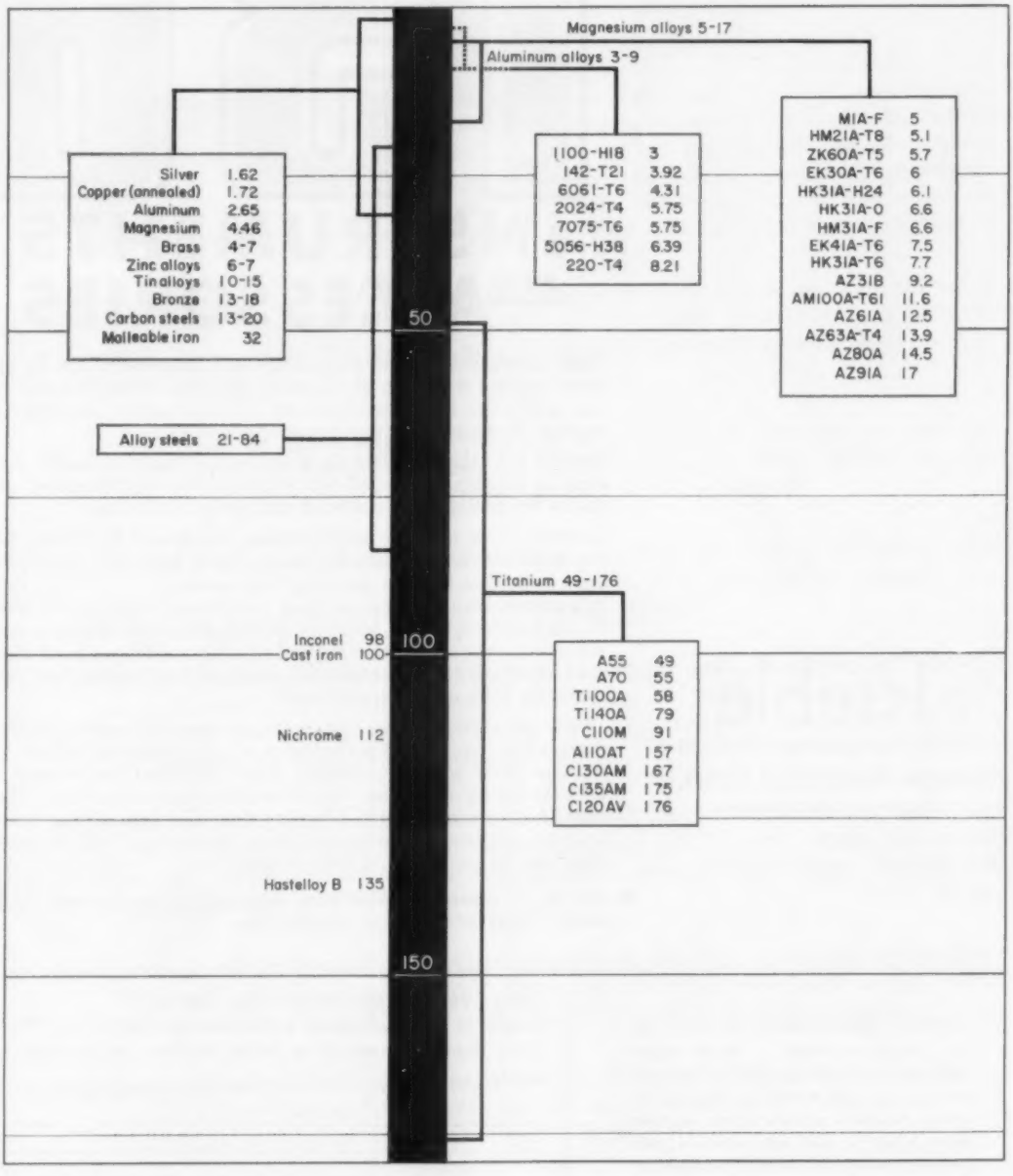

Courtesy: Brooks & Perkins, Inc.

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Price cuts on a new series of epoxy resins described as epoxidized polyolefins have been announced by the Chemical & Plastics Div. of Food Machinery and Chemical Corp. The resins, called Oxiron, are currently available in carload lots at prices ranging from 60 to 80¢ per lb. Previously, the resins were available only in developmental quantities at $1.75 to $2.25 per lb. The resins were introduced last spring (M/DE, Apr '60, p 19).

More high density polyethylene will be available when National Distillers and Chemical Corp.'s new plant in Houston, Tex. begins production in the fourth quarter of 1962. The plant has a rated capacity of 60 million pounds per year. Meanwhile, Hercules Powder Co. says it now has on stream a 60-million-pound-per-year polyolefins plant at Lake Charles, La. Initial production will be confined to polypropylene. A second plant of equal capacity will be completed in 1962, according to Hercules.

Price of cesium metal has been cut 50% by Penn Rare Metals Inc. New prices are $100 per lb for 99.5% pure grade metal in lots of 1000 lb or more and $125 for 99.9% pure metal. The firm's products are sold through Kawecki Chemical Co., Boyertown, Pa.

A new producer of glass fibers is Pall Corp., Glen Cove, N. Y. The company is building an integrated glassmaking and fiber drawing plant at Wilkes-Barre, Pa. that will have an annual capacity of approximately 10 million pounds.

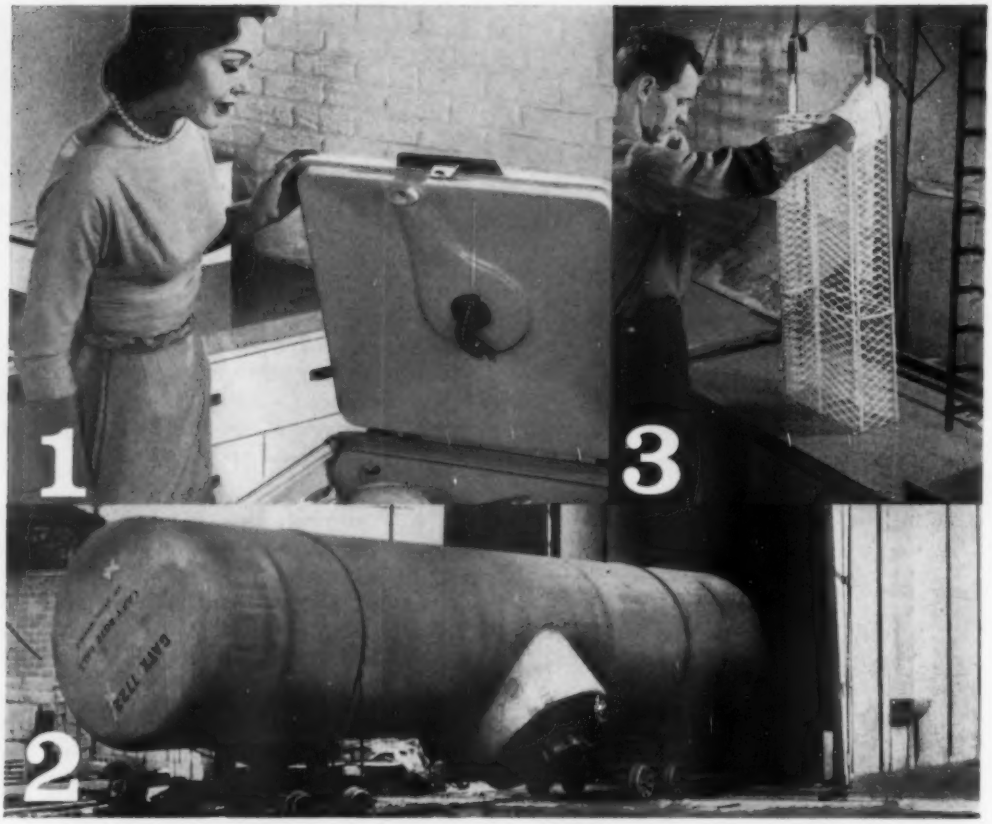
More wood particle board is available as the result of the start-up of United States Plywood Corp.'s new plant in South Boston, Va. The plant has an annual rated capacity of 30 million square feet of ¾-in. thick board.

A 10% cut in the price of type 410 stainless steel mill products has been announced recently by Carpenter Steel Co., Reading, Pa. New prices are 31½¢ per lb for hot and cold finished bars, 26¾¢ for billets and 29¾¢ for wire. Prices for strip and cold heading wire remain unchanged.

High purity zirconium, columbium and thorium are now available as crystal bars $\frac{5}{16}$ in. in dia by 20 in. long from Metal Hydrides Inc., Beverly, Mass. The crystal bars are expected to be used in developmental work in the nuclear, aircraft and other industries.

An 8¢-per-lb cut in the price of vinyl plastisols has been announced by the Coatings Div. of Metal & Thermit Corp. New prices for Unichrome 5300 in gray, green or black are 75¢ per lb in 1-gal quantities and 59¢ per lb in 100-gal and larger lots.

Two new producers of beryllium oxide are United Technical Industries Inc. of Salt Lake City, Utah and Mineral Concentrates and Chemical Co., Inc., Denver, Colo. The ceramic is supplied in purities from 96 to 99.999%.



Size and severe service prove no deterrents to plastisol usage

In the family of finishing materials available today, plastisols provide some of the most versatile of coatings for severe end-use conditions. They combine the well known chemical inertness of vinyl resins with heavy film buildup, resiliency, and truly remarkable wearing and abrasion resisting qualities.

Such physical advantages are applicable not only on the production line but also in many unusual protective maintenance jobs. As long as the metal object can be heated and held to the required curing temperature of 350°F for 20 minutes, plastisols can replace and improve on many other types of coating materials; or permit use of ordinary metals where costly alloys or other materials are generally needed. Examples:

1. **DISHWASHER TUB LINING.** Consider the service conditions: scalding water, mixed with strong cleaners, impinging with high velocity on tub. Add to this the need to resist food stains, to avoid cuts and impact damage from dropped or broken objects. Despite all service hazards, the lining must be able to last the life of the machine. A Unichrome Plastisol Compound satisfies these rigorous conditions, and more, for a number of famous dishwasher lines.

2. **INERT TANK CAR LINING.** Sprayable Unichrome Super 5300 Plastisol solved this problem, too, permitting use of a steel car instead of an expensive alloy one. Three sprayed coats gave a lining 120 mils thick. There were no seams at bends and joints to cause trouble; nor any thin spots to be penetrated. In effect, it was like applying a sheet lining through a spray gun. Baking, of course, was a gigantic job, requiring an oven 60 feet long. But result is a car capable of countless trips without risk of contaminating edible or chemically active contents.

3. **PROCESSING RACKS.** No stronger testimonial of durability exists for Unichrome Plastisol Coating than its use for electrically insulating a plating rack. It's immersed in hot, acidic or alkaline plating baths; again in boiling cleaners, even goes through vapor degreasing cycles. The coating withstands physical abuse, impact. Yet, it goes on and on, for thousands of plating cycles. Some plants report up to six years of service with minimum maintenance.

Send for data, or specific recommendations on a formulation to fit your requirements.

M&T coatings and finishes

METAL & THERMIT CORPORATION GENERAL OFFICES: RAHWAY, NEW JERSEY IN CANADA: M&T PRODUCTS OF CANADA LTD., REXDALE, ONT.

For more information, turn to Reader Service card, circle No. 417

Two Big Spring Shows

Design Show

6th Annual Design Engineering Show and Design Engineering Conference

May 22-25,
Cobo Hall, Detroit

Plastics Show

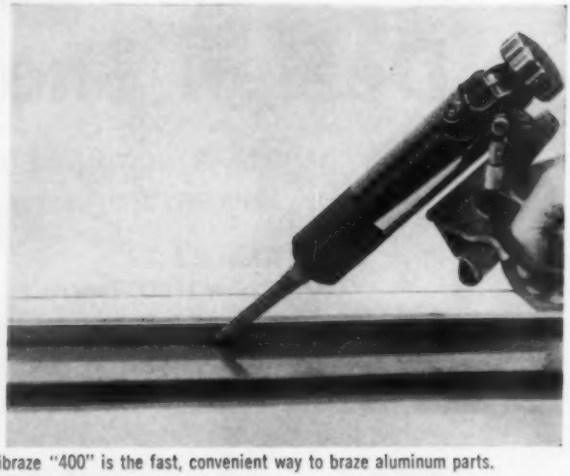
9th National Plastics Exposition and Conference

June 5-9,
New York Coliseum,
New York City

- ***How to Register***
- ***Conference Programs***
- ***Exhibitors***

plus . . . What's New at the Shows:
a preview of the most significant new materials and processes to be unveiled at the shows.

Now-join aluminum with new ease



Applied with equal facility to small joints or large seams, new Alumibraze "400" is the fast, convenient way to braze aluminum parts.

If your work involves joining aluminum alloys, there's a good chance you're already familiar with the advantages of Handy Alumibraze—the salt bath brazing method that provides strong, sound, corrosion-resistant joints—with excellent reproducibility—more readily than preforms—while reducing tool and fixture costs.

Now, Handy & Harman has developed a new preparation—Alumibraze "400"—for even greater ease of application. Containing the same active ingredients as before, Alumibraze "400" is formulated to provide a homogeneous paste that can be extruded onto parts by a gun or other method.

Extrudable Handy Alumibraze "400" is ideal for brazing complex assemblies like these.

Think of the trouble this saves you. You can join extended areas and complicated contours more conveniently than ever before. Cut application and assembly times way down. Reap all the benefits of high-volume production.

Don't let another day go by without learning how Alumibraze "400" can speed operations in your shop. Our recently-expanded Bulletin 23 supplies full details. It's yours for the asking.

Your No. 1 Source of Supply and Authority on Brazing Alloys

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General Offices: 850 Third Avenue, New York 22, N.Y.

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6th Annual Design Engineering Conference and Design Engineering Show

May 22-25, 1961
Cobo Hall, Detroit

The Show

The Design Engineering Show, one of the nation's largest annual industrial expositions, will be even larger and more complete than the extremely successful Show held in New York City last year. Devoted exclusively to the needs of the design engineer, the Show will consist of exhibits demonstrating the latest developments in engineering materials, services, components and product designs.

The 1961 Show, sponsored by Clapp & Poliak, Inc., also concentrates on the theme: "Designing for Today's Competitive Market." Technical experts from more than 400 leading companies will be in attendance at the exhibits to give advice, demonstrate new materials and processes, answer questions, distribute technical data, supply samples of new materials and conduct performance tests.

Five groups of exhibits will be of particular interest to engineers in the materials field: 1) metals, 2) nonmetallic materials, 3) fasteners and adhesives, 4) finishes and coatings, and 5) shapes and forms. Other exhibits include: electrical and electronic components; hydraulic and pneumatic components; mechanical components; power transmission equipment, and engineering equipment, services and publications. (See complete list of exhibitors starting on page 169.)

Visitors will be especially welcome at the MATERIALS IN DESIGN ENGINEERING booth, No. 963.

The Conference

A panel of top executives of the automotive industry will open the Design Engineering Conference. They will tell how engineering, production, and purchasing groups work together to make better cars to meet continuing competition.

A total of 30 speakers, drawn from the top level of the nation's design engineers, will lead discussions in other sessions of the Conference which will run concurrently with the Design Engineering Show.

The Conference, to be held in Cobo Hall, Detroit, will focus on the problems of "Designing for Today's Competitive Market." It is sponsored by the Machine Design Div. of the American Society of Mechanical Engineers.

The wide range of Conference topics will include: filament-wound structures, die cast automobile engine blocks, molybdenum disulfide dry lubricants, glass and ceramics, plastics, adhesives, powder metals, and designing for tape-controlled machine tool production. (See complete program starting on page 165.)

How to Register

This year's Show carries a registration fee of $2 which can be paid at any time during exhibition hours—from 12 noon to 5:30 p.m., Monday, Wednesday and Thursday, May 22, 24 and 25; and 12:00 noon to 10:00 p.m. Tuesday, May 23—at the registration desk in Cobo Hall, Detroit. Advance rapid registration forms and inquiry time saver plates can be obtained from Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y. Registration for the Conference can be accomplished at the ASME desk in Cobo Hall, from 8:30 a.m. to 4:30 p.m., May 22-25. The Conference fee, $10 for ASME members and $15 for nonmembers, entitles registrants to attend all Conference technical sessions, as well as the Design Engineering Show itself. In addition, each registrant will receive copies of all papers delivered at the Conference.

ASARCON

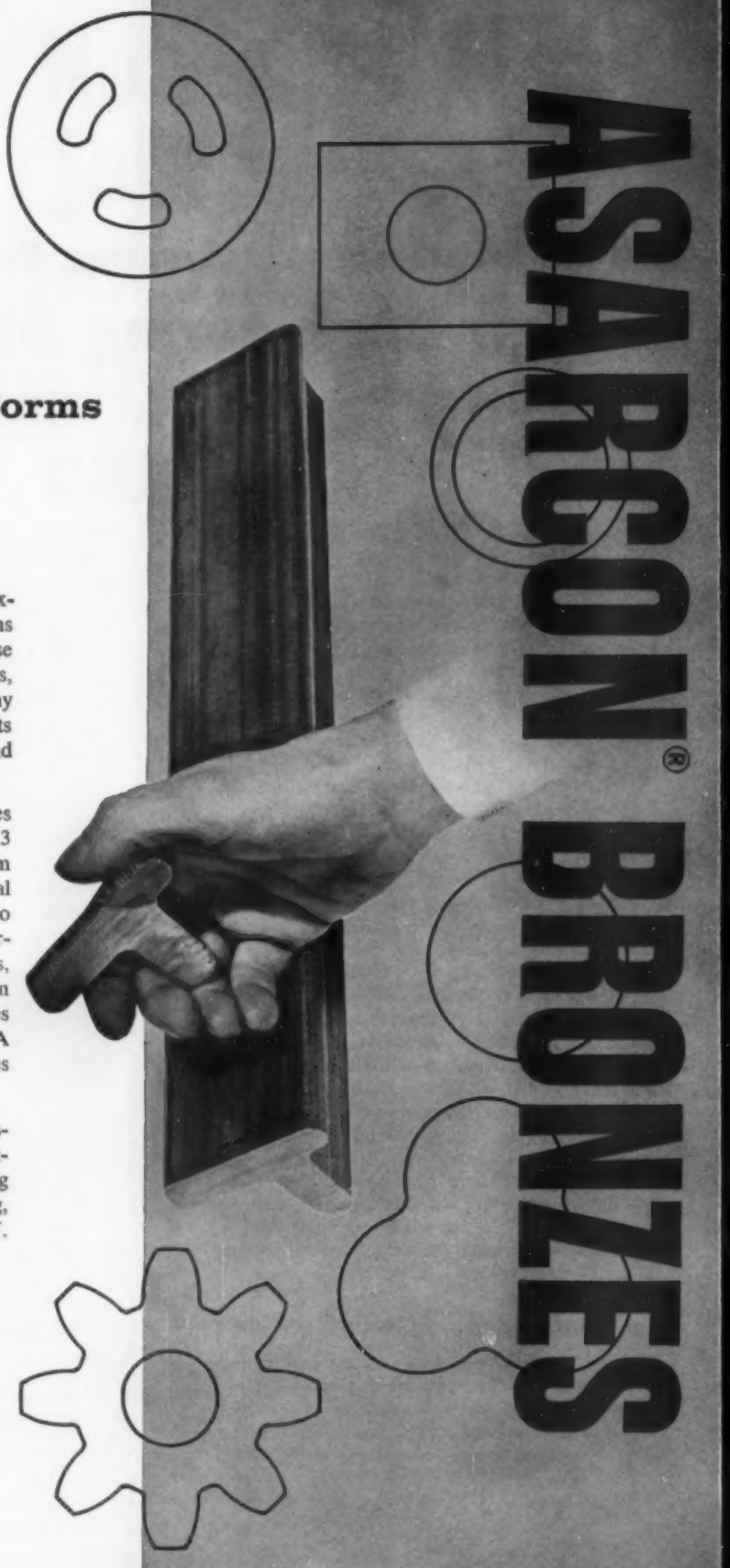
custom shapes and forms in any lengths you need

Asarcon continuous castings give you an extremely wide variety of shapes and forms in standard bronze alloys. They will increase your production rates and lower your costs, because: you get the shape you want in any length you need up to 20 feet. This permits machining on automatic screw machines and other high-speed equipment.

Continuous casting of Asarcon bronzes raises fatigue characteristics of standard alloys 33 to 100%, increases impact strength from 15% to more than double that of identical alloys cast other ways, adds materially to tensile, yield strengths and hardness. Asarcon 773 (SAE 660) bearing bronze in solids, rods and tubes is immediately available from stock in your choice of more than 260 sizes up to 9" O.D. and lengths up to 105". A wide variety of other special alloys, shapes and sizes produced to order.

For complete data on Asarcon continuous-cast bronze, write Continuous-Cast Department, American Smelting and Refining Company, Perth Amboy, N. J., Whiting, Ind.; or 120 Broadway, New York 5, N. Y.

ASARCO



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R. L. Thorkildsen

J. V. Schmitz

R. A. Lula

Five Speakers on Materials . . .

W. C. O'Leary

M. G. Britton

Program of Technical Sessions

Monday, May 22

10 a.m.

Designing for Today's Competitive Market

Moderator: EUGENE J. HARDIG, vice president and chief engineer, Automotive Div., Studebaker-Packard Corp.

Secretary: HENRY B. HORLDT, chief engineer, Special Machine and Engineering Inc.

Panel: *How a Car Is Planned and Engineered with Marketing, Purchasing, Manufacturing and Quality Control Considerations,* WILL SCOTT, executive director, Central Product Planning Office, Ford Motor Co.

Designing for Function and Cost Objectives, HERBERT M. BEVANS, executive engineer, Chassis, Electrical, Truck Section, Engineering Div., Chrysler Corp.

Production Engineering As It Affects Car Design and Sales, CONRAD F. ORLOFF, assistant chief engineer, Production Engineering Dept., Chevrolet Motors Div., General Motors Corp.

Role of the Supplier in Meeting Competition, CARL E. BURKE, chief development engineer, American Motors Corp.

Tuesday, May 23

9:30 a.m.—Four Concurrent Sessions

Manufacturing—Key to Saving

Co-Chairmen: FRED R. SWANSON, chief engineer–new products research, Sundstrand Machine Tool Div., Sunstrand Corp. WALTER R. OPEL, chief engineer, Cross Co.

Speakers:

Producibility—Designing for Production, C. EDWARD WARNER, manager, Advanced Manufacturing Engineering, General Electric Co.

Material Standardization to Reduce Costs, GERALD L. SWARTWOOD, material engineer and drafting supervisor, Bryant Electric Co.

Automatic Equipment—Speeds Production

Co-Chairmen: EDWARD I. BROWN, director of engineering, Machinery Hydraulics Div., Vickers Inc. EARL A. THOMPSON, president, Earl A. Thompson Mfg. Co.

Speakers:

Special Requirements of Hydraulic Circuits for Servo Controlled Machinery, ROBERT K. SEDGWICK, assistant chief engineer, Servo Div., Kearney and Trecker Corp.

Drives for Tape-Controlled Machine Tools, GEORGE W. YOUNKIN, chief development engineer, Giddings & Lewis Machine Tool Co.

Glass and Ceramic—Offer New Design Possibilities

Co-Chairmen: WILLIAM R. BENN, manager, Market Development Dept., Research and Development Div., Carborundum Co. L. R. LARSEN, sales engineer, Beryllium Corp.

Speakers:

Ceramic Materials: A Chemical and Structural Description, MARVIN G. BRITTON, technical manager, Government Services Dept., Corning Glass Works.

What Do Glasses and Ceramics Offer the Design Engineer, JOHN R. BLIZARD, manager, Product Engineering Dept., Technical Products Div., Corning Glass Works.

High Strength Steel—Impact of Recent Developments

Co-Chairmen: CHARLES B. SALTER, chief engineer, Weapons Systems, U.S. Army Ordnance Tank-Automotive Command. RALPH G. GILLESPIE, advertising and public relations director, Brooks & Perkins Inc.

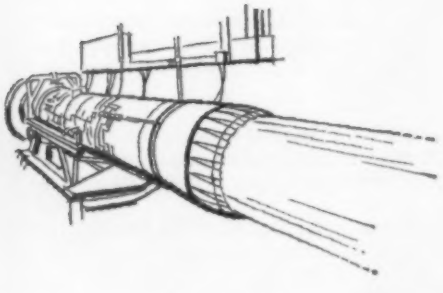
Speakers:

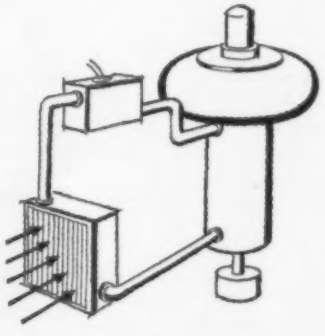
High Strength Steels— Part I, Materials, R. A. LULA, chief research metallurgist–stainless steel, Allegheny Ludlum Steel Co.

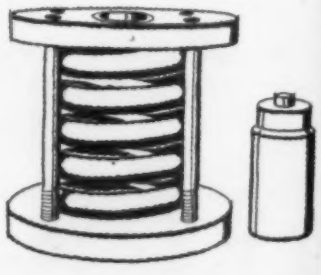
SILICONES

GOING INTO HUNDREDS OF PRODUCTS
WHICH NEED THE THERMAL STABILITY,
LONG LIFE, CONSTANT VISCOSITY
AND COMPRESSIBILITY OF

General Electric Silicone Fluids







Extreme temperature lubricants For high temperature lube applications, General Electric silicone lubricating fluid Versilube F-50 gives unmatched thermal and oxidative stability over the temperature range of —100°F to 600°F. Its lubricity is unequalled at temperatures as high as 600°F, and comparable to other fluids in the moderate ranges. Excellent hydrolytic stability. Not corrosive to common metals.

Dielectric coolants The extreme long life and thermal stability of G-E silicone fluids make them ideal as heat transfer media. Fluids of the SF-97 series can be pumped over a wide temperature range and will last indefinitely at 300°F in the presence of air, and more than 500 hours at 570°F in the absence of air. Further benefits include low volatility, chemical inertness, resistance to oxidation, and high dielectric strength.

Compressible fluids This liquid spring, which u
lizes the compressibility of G-E silicone flui
can do the same work as a conventional spri
five times as heavy. All G-E silicone fluids ha
relatively constant viscosity over wide tempe
ture ranges, and high-temperature stability. V
cosities range from 5 to 100,000 centistokes
25°C. Ideal for hydraulic fluids, fluid driv
dashpots, and dampers.

For more information, circle No. 464

The benefits of General Electric silicone fluids find uses in hundreds of products, from jet engines to suntan lotions. To learn more about these versatile, problem-solving fluids, write: General Electric Company, Silicone Products Dept., Section B547, Waterford, New York.

GENERAL ELECTRIC

High Strength Steels—Part II, Design and Fabrication, RICHARD H. MARVIN, chief engineer, Space Atomics Section, Product Development Dept., Budd Co.

Wednesday, May 24

9:30 a.m.—Four Concurrent Sessions

Motors—Economics and Applications

Co-Chairmen: FORREST E. BRAMMER, head, Dept. of Electrical Engineering, Wayne State University. JAY W. PICKING, manager, Control Div., Reliance Electric and Engineering Co.

Speakers:

Electric Motors at Higher Temperatures for Industrial Usage, FRANK C. RUSHING, engineering manager, Motor and Gearing Dept., Westinghouse Electric Corp.

Mechanical Application of Non-Excited Synchronous Motors, J. P. LANDIS, development project engineer, Electromechanical Development Section, Mechanical Development Laboratory, E. I. du Pont de Nemours & Co., Inc.

Production—Cost Saving Hints

Co-Chairmen: H. S. CLINE, manager, Mechanical Experimental Section, Mechanical Development Laboratory, E. I. du Pont de Nemours & Company Inc. WILLIAM L. WACHS, manager of engineering service, Cimtrol Div., Cincinnati Milling Machine Co.

Speakers:

Design Techniques for Simplified Programming of Neumerically Controlled Machine Tools, ALEXANDER TALEFF, equipment development engineer, Headquarters Manufacturing Laboratory, Westinghouse Electric Corp.

Cost and Value of Small Tolerances and Smooth Finishes, W. B. GILBERT, manager, Machining Development Service, Manufacturing Engineering Service, General Electric Co.

Adhesives—For Metal Bonding

Co-Chairmen: NICHOLAS J. DELOLLIS, materials engineer, Sandia Corp. SUMNER B. TWISS, president, Cycleweld Chemical Products Div., Chrysler Corp.

Speakers:

Adhesives: Types and Characteristics, W. C. O'LEARY, technical director, Adhesives, Coatings and Sealers Div., Minnesota Mining and Mfg. Co.

Factors in Joint Design Using Adhesives for Metal Bonding, KENNETH F. CHARTER, director, and HARRY R. BUTZLAFF, supervisor, Plastics Research, A. O. Smith Corp.

Cost Analysis—Fasteners and Powder Parts

Co-Chairmen: PAUL D. FROST, chief, Metals Economics Research, Dept. of Metallurgy, Battelle Memorial Inst. CHALMERS DALE, president, Charles Hardy Inc.

Speakers:

Which Fastener Should We Choose? JOHN W. STOUTENBERG, vice president, Robins Products Co. and KENNETH D. RINGLAND, chief engineer, New England Div., Central Screw Co.

Designing with Powder Metallurgy to Improve Quality and Reduce Cost, PAUL J. FAILLA, general superintendent–machine shops, Johnson Bronze Co.

Thursday, May 25

9:30 a.m.—Three Concurrent Sessions

Plastics—Unusual Behavior

Co-Chairmen: JOHN D. YOUNG, manager, Automotive Dept., Polychemical Dept., E. I. du Pont de Nemours & Co., Inc. JAMES E. FITZGERALD, manager of manufacturing, Brunswick International.

Speakers:

Filament Wound Pressure Vessels, RICHARD GORCEY, group leader, Solid Propulsion Structural Components, Rocketdyne Div., North American Aviation Inc.

An Introduction to Designing with Plastics, R. L. THORKILDSEN, mechanical behavior engineer, General Engineering Laboratory, General Electric Co. and JOHN V. SCHMITZ, manager–chemical research, Major Appliance Chemistry Laboratory, General Electric Co.

Dynamics—Damping and Gears

Co-Chairmen: ERIC E. UNGAR, senior engineering scientist, Bolt, Beranek and Newman Inc. ALBERT BEAM, staff engineer, Vinco Corp.

Speakers:

Vicso-Elastic Damping, D. KENT HATCH, JR., engineer, Production Engineering Group, Plastics Div., Engineering Dept., and C. HOWARD ADAMS, manager, Product Engineering, Monsanto Chemical Co.

Effect of Misalignment on Tooth Action of Bevel and Hypoid Gears, MERIWATHER L. BAXTER, JR., chief research engineer, Gleason Works.

Lubrication—Molydisulfides as an Answer

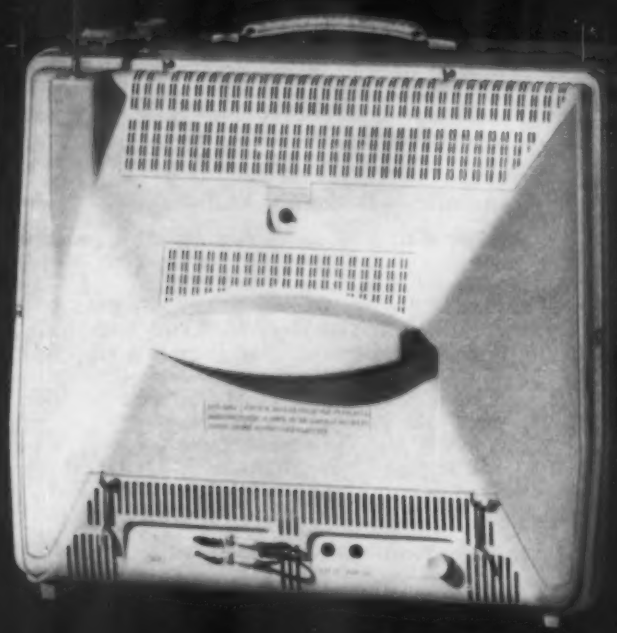
Co-Chairmen: ALFRED SONNTAG, president, Alpha-Molykote Corp. STANLEY L. COSGROVE, assistant chief, Lubricants Chemistry, Battelle Memorial Inst.

Speakers:

Molybdenum Disulfide as a Lubricant, KENNETH B. WOOD, JR., manager, Chemical Div., Climax Molybdenum Co., Div. of American Metal Climax Inc.

Molybdenum Disulfide as an Additive to Improve the Performance of an Automotive Multipurpose Grease, H. G. RUDOLPH, JR., Automotive Div., Products Dept., Socony Mobil Oil Co., Inc.

there are always good reasons for designing it in AVISUN polypropylene



AviSun Polypropylene's good molding characteristics permit an intricately vented back with cross-members less than 1/8 inch wide. Custom-molded by Sinko Manufacturing & Tool Co.

See your souvenir AviSun polypropylene pill box with self-hinge injection molded on the new high speed Rotojet . . .

BOOTHS 1151-1248

National Plastics Exposition

New York Coliseum June 5-9

in TV backs *it's toughness, heat resistance, good insulation*

Styling is most important in portable TVs. For the backs of their sets, Motorola needed an attractively molded back with good insulating properties, high heat resistance, and tough enough to stand hard bumps. Only polypropylene could meet their quality specifications. The back, molded in one piece from AviSun polypropylene, is warp-free, economical to manufacture, and easy to assemble.

Polypropylene makes better products at lower cost. No other material has this combination of properties:

1. **Heat Resistance**
2. **Chemical Resistance**
3. **Toughness**
4. **Economy**

AviSun polypropylene is being used in new applications every day—from Pulspirators to TV backs. New production facilities, now under construction, will soon be ready to meet the growing demand for this versatile new material. Send for Booklet AP-601, giving complete information on AviSun polypropylene.

AVISUN CORPORATION
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1345 Chestnut St.
Philadelphia 7, Pa.

AVISUN*

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Nickel-Chrome Plating shines through the years of wear she'll give this bicycle

Nickel-Chrome Plating is more than a match for the hard wear that means bicycling fun for youngsters. It's beautiful, it's durable—*and stays that way*—despite rain, dust, bumps and scratches.

Rugged resistance to corrosion and lasting protection for the basis metal are why the manufacturers of this beautiful bicycle specify Nickel-Chrome Plating. It's put to work where wear is at its worst—on cranks, sprockets, wheel rims, fenders, handlebars and wire and tubular luggage carriers.

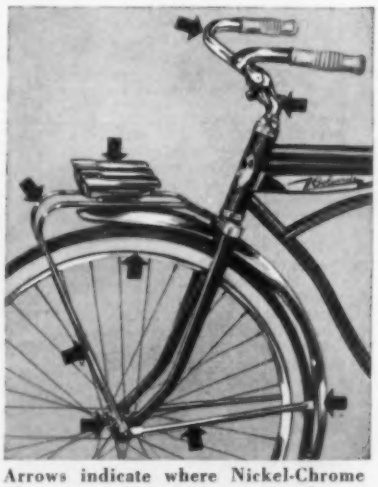
Nickel-Chrome Plating works so well with so many basis metals. It gives designers true flexibility in selecting basis materials for top performance, simplified fabrication, and practical production cost. And it gives metal finishers a coating system that protects the product for years of rugged wear.

Plan to use Nickel-Chrome Plating. Automotive trim...large and small appliances...hand plumbing fixtures...almost any product can have a durable, attractive finish—no matter what basis metal or fabricating method is used. For more information on decorative plating, write for your copy of "The Contribution of Nickel and Chromium to the Durability of Decorative Plating."

The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

Inco Nickel

Nickel makes plating perform better longer



Arrows indicate where Nickel-Chrome Plating is used for shining good looks and rugged service.

For more information, turn to Reader Service card, circle No. 502

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PRODUCT-DESIGN BRIEFS FROM DUREZ

- **High-impact phenolics for shock environments**
- **Fast forming with thermosetting resins**
- **Fire retardance plus in structural plastic**

Better impact strength

The reverse clutch cone pictured here is molded of Durez 16771, a high-impact phenolic material made with fibrous glass. The cone does duty as a brake against which the steel ring gear of a planetary train is stopped while the transmission is under full power.

In this application, the part is buffeted by murderous static and dynamic friction, developed heat, and the 5000-lb. force of the actuating piston. It must also do battle with the chemical effect of transmission oil.

The test performance proved that the phenolic part does a better job than metal in all respects. You would therefore expect it to do equally well in other shock environments—and you'd be right. A few examples: stud-welding gun, rocket nozzle, compressor support, motor end-bell, washer sheave, missile nose cone.

Durez 16771 abounds in unique advantages, the most valuable of which is its refusal to warp or shrink. You can mold parts to exact dimensions, without needing to allow for shrinkage.

If *you'd* like a closer look at the properties and design advantages of high-impact phenolics, we'd like to send you a reprint of an article written for *Product Engineering*.

A resin that forgets

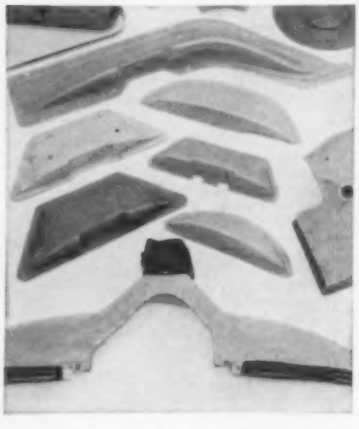
Forgetfulness is a virtue in this material.

It is a prepreg, commonly called "forming board," made from kraft fibers in which Durez phenolic resin has been dispersed as binder. The producer of the prepreg, whose name we'll be glad to send you on request, supplies it in thicknesses ranging from .060 to .150 inch, and in sheet sizes to 55 x 72 inches. A sheet can be stored two years at 70° F without losing its usefulness.

Squeezed at 300-500 psi in a hot press, the prepreg "sets" within 5 to 15 seconds to become a strong, rigid molded shape that will withstand moisture, heat and mild corrosives.

This is where forgetfulness comes in. There is no springback or "memory" effect in this forming board, because as it cures the resin changes its chemical nature to become a different substance, one of great durability.

As you might suspect, there are



many other uses for Durez thermosetting resins of interest to almost anyone developing new products. To get a better idea of how their interesting properties might help you, check the coupon for Bulletin D102, a 12-page idea book.

Delight for designers

Structural paneling which incorporates Hetron® polyester resin in its manufacture is proving a boon to designers concerned with safety and strength . . . a delight to decorators seeking the attractions of color and translucence.

Hetron paneling is fire-retardant. It does not sustain combustion. It offers the added benefits of light weight, un-

breakability, resistance to corrosion and to climatic extremes. It has high strength-to-weight ratio, excellent impact strength and finishing properties.

Other applications of Hetron range from auto fenders to portable hangars for jet aircraft. To enrich your knowledge of this versatile material, we'll gladly send you our Designer's Data File and the names of fabricators.

For more information on Durez materials mentioned above, check here:

- ☐ High-impact phenolic molding material (reprint of article)
- ☐ Thermosetting resins (12-page Bulletin D102)
- ☐ Hetron fire-retardant polyester resin (data file and fabricator list)

Check, clip and mail to us with your name, title, company address.
(When requesting samples, please use business letterhead)

DUREZ PLASTICS DIVISION
1405 WALCK ROAD, NORTH TONAWANDA, N. Y.
HOOKER CHEMICAL CORPORATION

HOOKER CHEMICALS PLASTICS

For more information, turn to Reader Service card, circle No. 321

9th National
Plastics Exposition
and Annual Conference

June 5-9, 1961
Coliseum, New York City

The Exposition

The latest in resins, molding compounds, coatings and finishes, extrusions and other plastics materials will be on display at the Ninth National Plastics Exposition to be held June 5-9 in New York City.

The Exposition will be held in New York's Coliseum at Eighth Ave. and 58th St. and will be open from 1-6 p.m., daily Monday to Friday, except on Thursday when it will be open from 1-9 p.m. Admission will be restricted to properly registered representatives of industry, education and government.

Exhibitors will include: raw materials suppliers; machinery and equipment manufacturers; tool, die and mold makers, injection and compression molders; laminators; extruders; reinforced plastics molders; film, sheeting and coated fabric processors; and testing and research laboratories.

A complete list of exhibitors appears on pp 179 and 181.

Visitors will be cordially welcomed at the MATERIALS IN DESIGN ENGINEERING booth, No. 1131.

The Conference

Addresses by prominent members of the plastics users industries will be the feature of this year's Conference program. Leaders in such fields as architecture and building, communications, packaging, transportation and defense products will describe the special viewpoints of their industries, their needs, and the directions they would like to see the plastics industry take.

The Conference will be held concurrently with the Exposition. All sessions will meet at the Commodore Hotel, 42nd St. and Lexington Ave., and run from 9:00 a.m. to 12 noon, June 6-8.

Question-and-answer periods after papers are given will enable every registrant to participate actively in the proceedings.

In addition, four SPI divisions will hold meetings. These groups are: Thermoplastics Structures, Vinyl Dispersions, Epoxy Resins Formulators, and Cellular Plastics.

An Industry Reception will be held Tuesday evening and an International Reception for visitors from abroad will be held Wednesday evening. Specific times and places have not yet been announced.

A detailed program for the Conference appears on pp 175 and 177.

How to Register

Registration for the Plastics Exposition is $2.00 and can be made at the Coliseum any time during exhibiting hours. Registration blanks are available from any exhibitor.

The Conference registration desk will be located at the Main Ballroom foyer of the Commodore Hotel. The desk will be open from 1:00 p.m. to 10:00 p.m., June 6-8.

The Conference fee, $25 for SPI members and $35 for nonmembers, includes admission to the Exposition, the SPI Luncheon, and the SPI Reception. The International Reception is not included.

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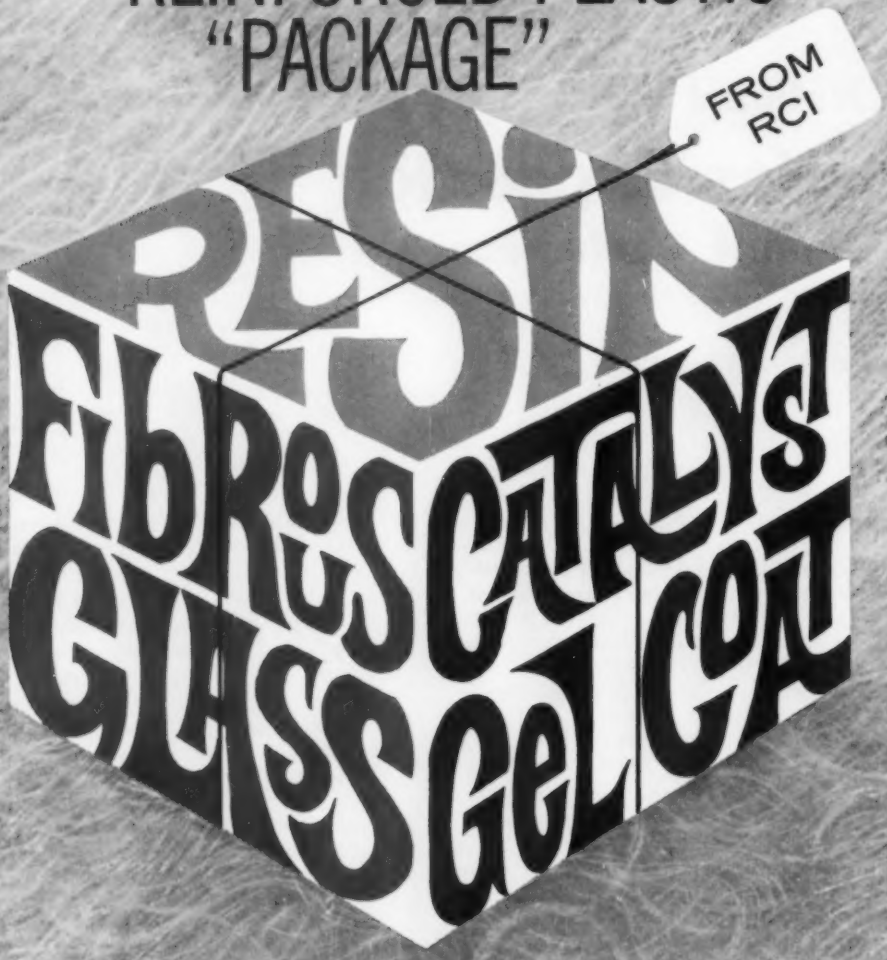

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Resins—polyesters, polyurethanes for foam, epoxies and phenolics from one of the world's most widely experienced manufacturers.

Gel Coats—for spray, brush or roller applications.

Catalysts—for both room temperature and heat curing formulations.

Fibrous Glass—newest addition to RCI's family of reinforced plastic products...surfacing mat, reinforcing mat for matched die molding, unidirectional mat and tape, chopped strand for pre-mix molding compounds.

Enjoy the convenience of buying top quality materials for your reinforced plastics needs from RCI.

REICHHOLD

REICHHOLD CHEMICALS, INC., RCI BUILDING, WHITE PLAINS, N.Y.

Program of Technical Sessions

Commodore Hotel

Tuesday, June 6

9:00 a.m.–12:00 noon—Four Concurrent Sessions

Plastics in Building: I—Applications

Grand Ballroom

Moderator: W. H. SCHEICK, executive director, American Inst. of Architects.

Speakers:

Architectural Needs and Applications for Plastics Including Existing Applications and Future Needs, GEORGE E. DANFORTH, director, Dept. of Architecture, Illinois Inst. of Technology, and chairman, Mid-Western Chapter, AIA.

A Builder Looks at Plastics, G. P. DORRANCE, Turner Construction Co.

Time and Use vs Plastics, W. ALLEN CLENEAY, architect.

Plastics' Role in Lighting, KIRK M. REID, past president Illuminating Engineers Soc.

Plastics in Building: II—Codes

Grand Ballroom

Moderator: FRANK AMBROSE, Alsynite, Div. Reichhold Chemicals, Inc., *Present Status of Code Machinery.*

Speakers:

Problems and Opportunities in the Building Codes, FRITZ RARIG, secretary, Rohm & Haas Co.

Codes at the Local Level, LEO GOLDSTEIN, P. E., staff engineer, City of Philadelphia.

Plastics in Communications

East Ballroom

Moderator: J. V. MCBRIDE, Plastic Wire & Cable Corp.

Speakers:

Plastics in the Recording Arts, C. J. MARTIN, Radio Corp. of America.

Plastics vs the Elements in Telephone Communications, JACK DECOSTE, Bell Telephone Laboratories.

Plastics in the Space Environment, ERIC LINDEN, Fort Monmouth Civilian Signal Communication Laboratories.

Plastics in Machinery

West Ballroom

Moderator: A. J. DE MATTEO, consultant.

Speakers:

New Developments in Machinery for the Thermoforming Industries, W. C. SCHLAGER, manager of sales engineering, Royalite Plastic Products, U.S. Rubber Co.

New Developments in Blow Molding Machines, R. BOYDEN, F. J. Stokes Corp.

New Developments in Injection Molding Machines, JAMES W. HENDRY, general manager, Machinery Development Laboratory, Marbon Chemical Div., Borg–Warner Corp.

New Developments in Extruders, ALBERT J. KAUFMAN, president, Prodex Corp.

Thermoplastic Structures Div., SPI

Windsor Ballroom

The Uses and Techniques for Fabrication of Rigid Thermoplastic Structures

Chairman: PAUL CHAMBERLAIN, Industrial Plastic Fabricators, Inc.

Speakers:

European Use of Polyolefins in Thermoplastic Structures, GERD BAUSBACK, Hoeschest Co., Germany.

The Manufacture and Fabrication of Polyolefins in Europe, motion picture.

Welding, Heat Sealing and Cementing Techniques Used in the Manufacture of Thermoplastic Structures, DONALD WOLFF, Plastics Div., Seiberling Rubber Co.

Fabrication of Plastics for Corrosion Control, ALFRED B. DEL 'ETOILE, Delbrook Engineering, Inc.

6:00 p.m.-8:00 p.m.

Industry Reception—Commodore Hotel

Wednesday, June 7

9:00 a.m.-12:00 noon—Four Concurrent Sessions

Plastics in Packaging

Grand Ballroom

Moderator: LLOYD STOUFFER, editor, *Modern Packaging.*

Speakers:

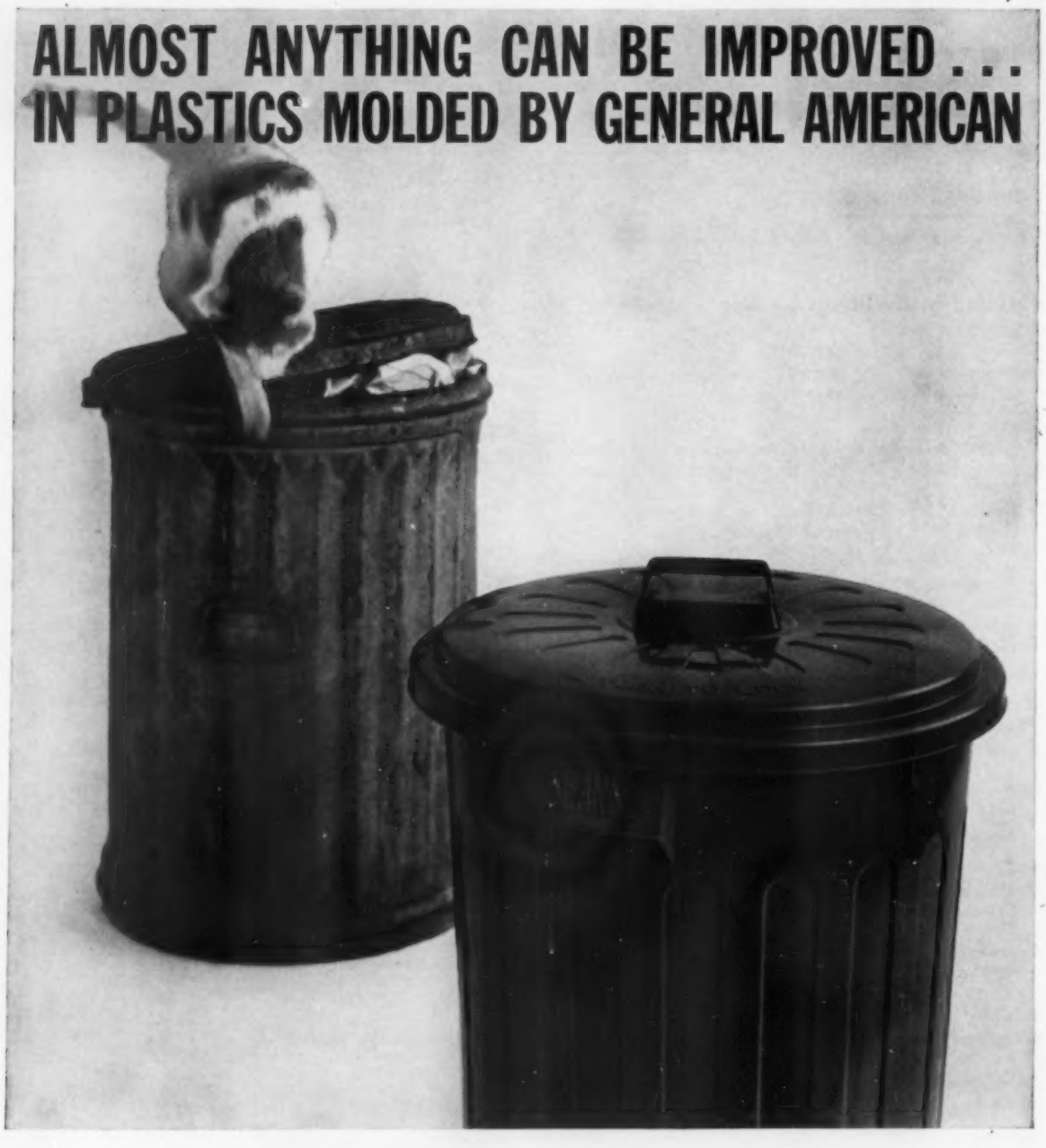
Present and Future Penetration of Plastic Packaging in 14 Major Markets, DONALD MAHANEY, market specialist, Monsanto Chemical Co.

Flexible Plastic Packaging Films, FLORREN E. LONG, manager, product development & research, Flexible Packaging Div., Continental Can Co

Plastic Bottles, Tubes and Other Merchandising Packages, ALVIN J. SANDERS, supervisor, Pack-

For more information, circle No. 345

ALMOST ANYTHING CAN BE IMPROVED . . . IN PLASTICS MOLDED BY GENERAL AMERICAN



Sears Roebuck wanted dent-proof, rust-proof, quiet refuse containers. General American helped provide the answer.

The line of containers General American helped develop for Sears varies in size from 20-gallon trash cans to two-quart pails. All are colorful and easy-to-clean; won't rattle or dent.

Resourceful solutions to plastics problems are not at all exceptional at General American. Our engineers and plastics specialists are backed by the largest, most varied molding facilities in the world: compression presses to 2,000 tons . . . injection presses to 300 ounces . . . large extruding and vacuum-forming machines.

If you'd like to move profitably into plastics, you'll certainly find it pays to plan with General American.

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Plastics Division

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age Construction Household Products Div., Colgate-Palmolive Co.

Rigid Plastic Nestable Containers, F. NORMAN HARTMANN, vice president, planning and development, Lily-Tulip Cup Corp.

Plastics in Transportation

East Ballroom

Moderator: HARTLEY BARCLAY, publisher, *Automotive Industries.*

Speakers:

Current Uses and Requirements, THOMAS H. RISK, Ford Motor Co.

The Purchasing Agent Looks at Plastics, JACK MORAN, Chrysler Corp.

The Role of the Processor, J. J. O'CONNELL, Consolidated Molded Products Corp.

Looking to the Future, M. F. GARWOOD, Chrysler Corp.

Panel: JOHN YOUNG, E. I. du Pont de Nemours & Co., Inc.; JOHN SLATER, Tennessee Eastman Co.; JACK DOYLE, Rohm & Haas Corp.; HARRY MCGOWAN, Union Carbide Corp.

Vinyl Dispersions Div., SPI

Windsor Ballroom

Chairman: FRANK CAPLAN, Reynolds Chemical Products Co.

Speakers:

General Introduction to Vinyl Dispersions, DONALD MESERVE, Metal and Thermit Corp.

Uses of Vinyl Dispersions—Present and Future, ROBERT HENSON, Flexible Products Co.

Role of Custom Formulator in the Vinyl Dispersion Industry, ROBERT MCTAGUE, Stanley Chemical Co.

Epoxy Resin Formulators Div., SPI

West Ballroom

Breadth and Scope of Epoxy Applications

Moderator: DONALD ROON, Hysol Corp.

Speakers:

Adhesives, BERNARD GOULD, Rubber & Asbestos Corp.

Electrical, JOHN DELMONTE, Furane Plastics, Inc.

Tooling, CHARLES DOUGLAS, Marblette Corp.

New Applications, CECIL ARMSTRONG, Armstrong Products Co.

12:30-2:00 p.m.

Luncheon—Grand Ballroom

A Time of Trial, L. CHERNE, Research Institute of America, Inc.

Thursday, June 8

9:00 a.m.-12:00 noon—Three Concurrent Sessions

Plastics in Appliances

Grand Ballroom

Moderator: GORDON THAYER, Dow Chemical Co.

Speakers:

Market Goals for Appliances, HARVEY WEIMER, director of market research, Whirlpool Corp.

Designing Appliances for Functional Performance, CARL W. SUNDBERG, president, Sundberg & Ferar.

What the Appliance Industry Feels It Needs in the Way of Plastics Materials and Services, WILLIAM GOBILLE, vice president, Kelvinator Div., American Motors Corp.

The Bissell Shampoomaster, PETER J. KING, vice president–marketing, Bissell, Inc.

Plastics in Defense

East Ballroom

Moderator: JOHN HONISH, Union Carbide Plastics Co.

Speakers:

Plastics in Weapons, ALBERT LIGHTBODY, U.S. Naval Ordnance Laboratory.

Plastics in Over-All Defense, PAUL FORSYTH, deputy director, research and engineering, Office of Scientific Development, Dept. of Defense.

Plastics in Ship Construction, WILLIAM GRANER, U. S. Navy, Bureau of Ships.

Plastics in Space & Missiles, VICTOR N. SAFFIRE, Missile & Space Vehicle Div., General Electric Co.

Cellular Plastics Div., SPI

West Ballroom

Plastics Foams . . . at Home . . . at Work . . . at Play

Moderator: EDWIN EDBERG, Koppers Co.

Speakers:

Plastics Foams in Furniture, RICHARD C. ROE, director of engineering, Schmadig Corp.

Plastics Foams in Construction. Speaker not announced at press time.

Plastics Foams in Transportation, JAMES LEONARD, Lique Freeze Corp. of America.

Plastics Foams in Defense, MARIO GIGLIOTTO, Package Development Laboratory, General Electric Co.

Plastics Foams in Leisure Activity. Speaker not announced at press time.

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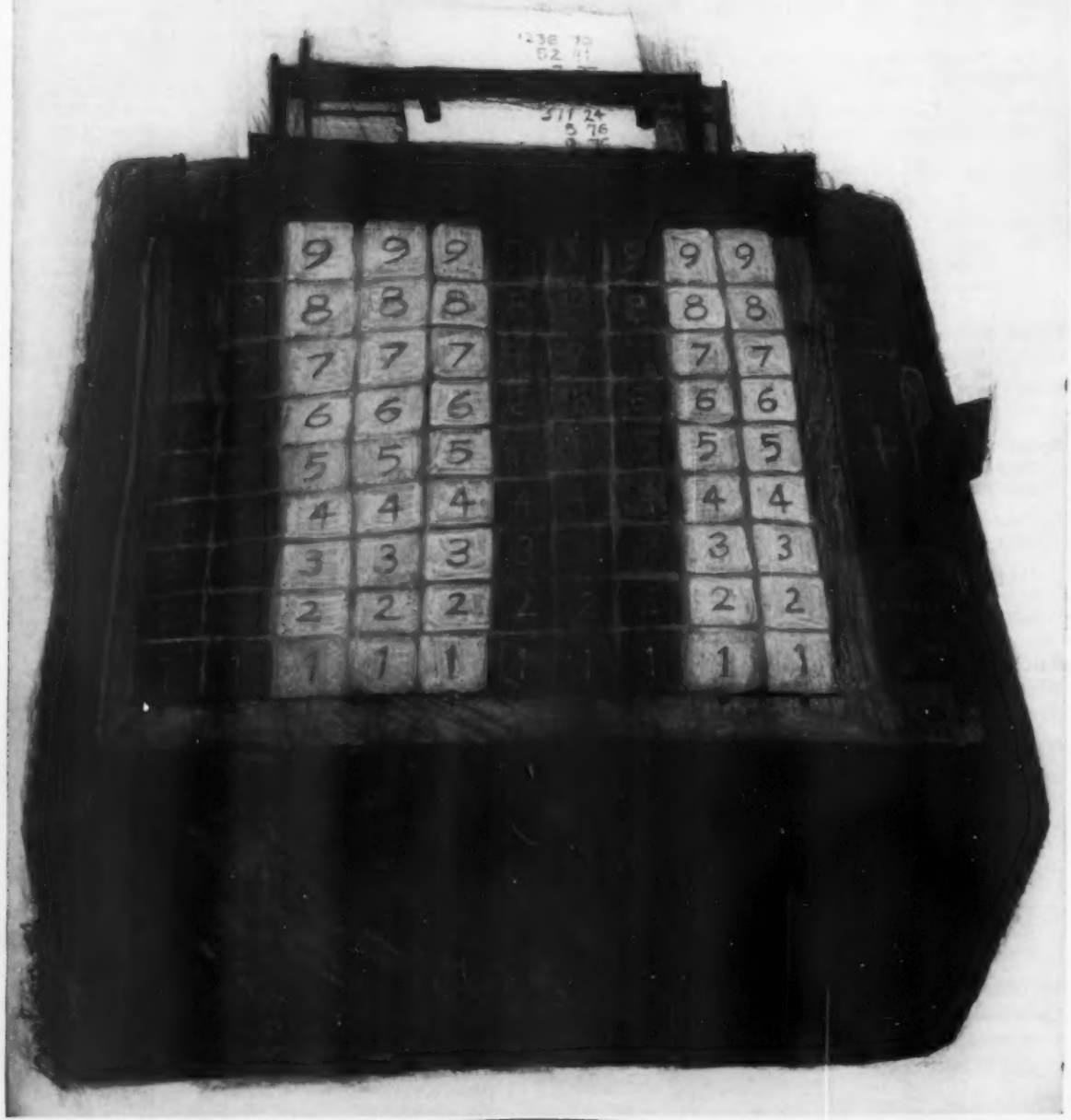
You save when you solve materials problems with Laminac®

Laminac polyester resin has been solving difficult materials problems for 19 years — and delivering substantial economies in the process. Reinforced Laminac offers you economical, high and low-volume fabrication of unusual shapes, large and small. Plus: Low-cost tooling • High structural and impact strength • Dimensional stability • Superior electrical properties • Arc resistance • Dielectric strength • Corrosion resistance. In one molding operation, reinforced Laminac gives form, strength, color and finish to business machine housings, furniture, photo processing equipment, food trays, countless other products. Put your materials problems to reinforced Laminac—the pioneer polyester. Write for free booklet, "Laminac Polyester Resins Selector."



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Exhibitors

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THAT EXTRA TOUCH OF GRACE: Market Research

A market researcher is a detective and Grace market research people are good detectives. If you need the facts on a plastics market, a potential demand, a trend... call Grace. The Grace Service Plan offers market research as one of ten major services available to Grace customers. On market research problems, it costs no more to call for that extra touch of Grace.

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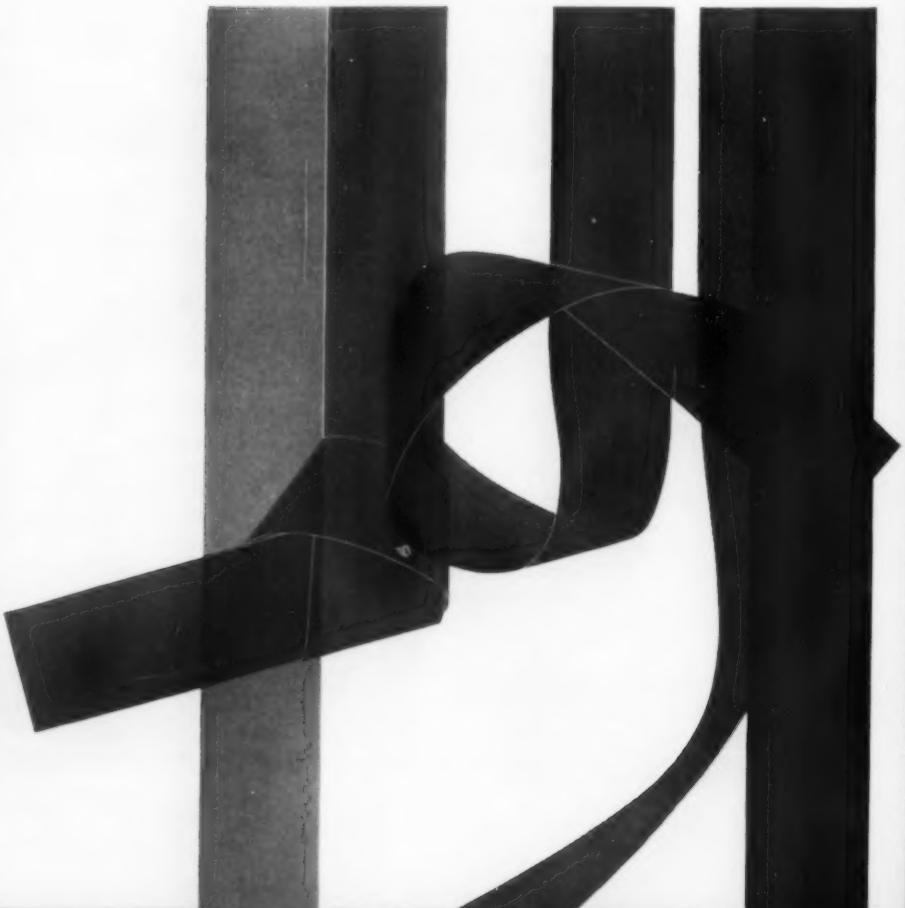


A significant advance in materials:

New Constructional Steel Is Strong, Ductile, Weldable

■ A materials advance of significance to many industries has been made with the development of an 18% nickel constructional steel designated MA-18NiCoMo.

The nickel steel was developed by International Nickel Co., Inc., 67 Wall St., New York 5, N. Y. It is currently available as plate on special order from alloy steel producers.

An impressive combination

The new alloy steel offers heat treated yield strengths as high as 300,000 psi and, according to Inco, may be the forerunner of a family of alloys having tensile strengths of 500,000 psi or higher. More notable at present, however, is the unusual combination of properties offered by the new steel at such high strength levels:

▸ *Good ductility.* The table shows that 300,000 psi yield strength is accompanied by a 60% reduction in area. This combination offers the designer formability and strength in one package. In addition, nil ductility transition temperature is low: −80 F.

▸ *High notched tensile strength.* Using a notch root radius of 0.0005 in., notched tensile strength levels of 450,000 psi have been developed (see table).

▸ *Readily weldable.* Automatic or manual methods can be used. Of utmost importance: sound, crack-free welds can be made on fully heat treated material without preheating. To restore strength, the weldment is heated to 900 F for 3 hr. Re-annealing is not necessary, and weld metal properties approach those of the parent metal.

Other advantages to consider: resistance to stress corrosion cracking, especially above 200,000 psi tensile strength, is high; low work hardening rate permits easy cold forming and shaping; and machining characteristics are good both in the annealed and hardened condition.

Heat treatment simple

The steel has a nominal composition of 18% nickel, 7% cobalt, 5% molybdenum, 0.5% titanium, and 0.05% max carbon. Note that although called a steel, the material's low carbon content makes it actually an alloyed nickel iron.

Heat treatment, accomplished by a new process called Mar-aging, is noteworthy because of its simplicity. When the 18% nickel alloy steel is properly finished on the rolling mill, an iron-nickel martensite forms during cooling to room temperature. Primary strengthening results from the formation of this carbon-free martensite which, because of its composition, is relatively tough (martensite formed in conventional steels contains carbon and is very brittle). Further strengthening is obtained by aging 3 hr at 900 F, followed by air cooling. The remarkable combinations of ultra high strength and ductility that result are shown in the table. Solution annealing at 1500 F prior to Mar-aging is optional.

Further details on the properties of this new kind of alloy steel will be published in M/DE within the next few months.

PROPERTIES OF MA-18NiCoMo[a]

Yld Str, 1000 psi ➡	215	260	300
Ten Str, 1000 psi	220	265	305
Notched Ten Str, 1000 psi[b]	350	400	450
Red. of Area	64	58	60

[a]Hot worked and Mar-aged. Strength levels depend on composition variations.
[b]0.0005-in. notch root radius.

Design Show Booth No. 529
M/DE KEY NO. 600

High Density Tungsten Alloy for Shielding, Balancing, Damping

A high density alloy for radioactive shielding, balancing and other applications has been developed by Kennametal Inc., Latrobe, Pa. The alloy, called Kennertium, is "free-machining" when cut with carbide tools. It contains 90% tungsten, 7.5% nickel and 2.5% copper.

PROPERTIES OF KENNERTIUM

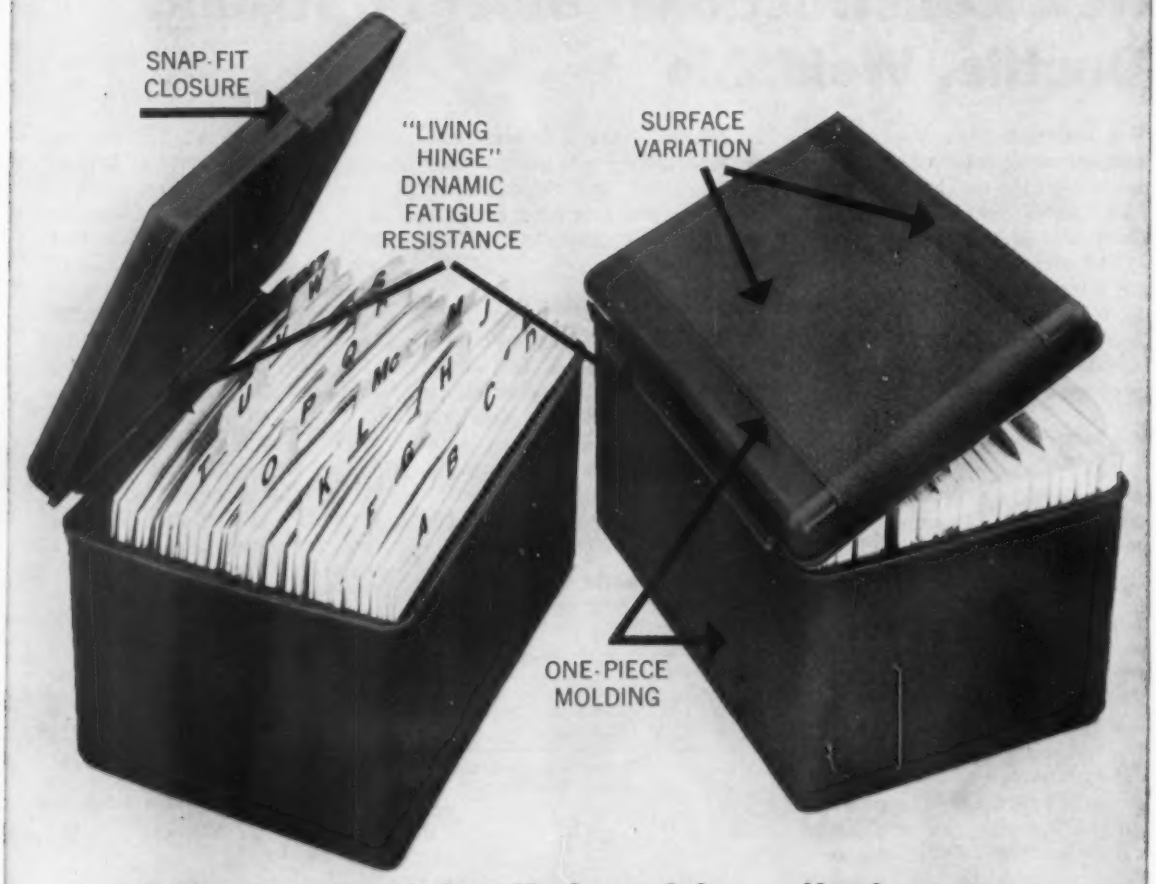
Density, lb/cu in.	0.61
Tensile Strength, psi	135,000
Yield Strength (0.2% offset), psi	75-90,000
Elongation (in 1 in.), %	15
Rockwell Hardness	C25-35
Modulus of Rupture, psi	180-225,000
Compressive Strength, psi	400,000

Twelve potential uses

Typical shielding, balancing and dampening applications include: radioactive containers; shielding for x-ray machines; capsules for oil well exploration; counterweights for variable pitch propellers; weights for self-winding watches; control instruments for guided missiles; motor vibration dampeners; camera shutter timing mechanisms; gyroscope rotors; centrifugal clutches; torsional vi-

◀ For more information, circle No. 493

WHAT'S NEWS IN PLASTICS



File box with "living hinge" shows design versatility of Escon® polypropylene

A "living hinge" with extraordinary life, snap-fit closures to replace metal parts, various surfaces—gloss, matte or textured—these are just three of the countless design possibilities when you mold with versatile Escon polypropylene. Testing of "living hinges" was discontinued after 1,300,000 flexes without signs of weakening.

Escon polypropylene offers molders a balanced combination of properties for high-speed, continuous production. These include resistance to acids, alkalies and corrosion; high strength; low volume cost; negligible water pick-up; high heat distortion point; excellent electrical characteristics; abrasion resistance; easy processing and many more. For technical assistance, write to Enjay at 15 West 51st St., New York 19, N. Y.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

ENJAY CHEMICAL COMPANY

A DIVISION OF HUMBLE OIL & REFINING COMPANY

ENJAY
PLASTICS

For more information, turn to Reader Service card, circle No. 469

bration dampeners; and governors.

The high density metal can be joined to itself or to other metals by silver or copper brazing, soldering, press or shrink fitting, and mechanical attachment.

Many standard forms

The new alloy is available in: solid sections up to 10 in. in dia by 20 in. long; cylinders several feet long; cold pressed rings up to 14 in. o.d.; hot pressed rings up to 25 in. o.d.; disks ¼ in. thick and up to 14 in. in dia; slabs ¼ in. thick and 14 in. square; and bricks 4 in. square by 8 in. long. Complicated sections with close dimensional control can also be made.

Explosive forming used

According to Kennametal, explosive forming is used to insure a dense, uniform part. Tungsten, nickel and copper powders are first blended together, then compacted into slugs by explosive techniques. The slugs are shaped to the desired form, sintered and machined to final shape.

Typical parts *that can be made from new heavy tungsten alloy.*

Design Show Booth No. 562
M/DE KEY NO. 601

Vinyl on Aluminum for Mass-Produced Parts

A vinyl-clad aluminum sheet called Vynalate has been introduced by Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19. The new material can be drawn, roll formed, corrugated, punched, embossed, crimped and expanded on a volume production basis, according to the producer.

The vinyl-clad sheet is produced in widths up to 48 in. and in thicknesses ranging from 0.016 to 0.051 in. It is available with any nonproprietary vinyl coating, as well as 39 color-pattern combinations. The product is supplied in all sheet forms, including coils, flats, circles and blanks.

Design Show Booth Nos. 721, 820
M/DE KEY NO. 602

Also Look for . . .

displays of these new materials and parts described in recent issues of this magazine:

Moldable Ceramoplastic for 1200 F, Mar '61, p 14, Design Show Booth No. 1063.

DAP Insulating Varnishes, Mar '61, p 19, Plastics Show Booth Nos. 1404, 1408, 1410.

Moldable Urethane Elastomers, Mar '61, p 15, Plastics Show Booth No. 1333.

Cementable FEP Fluorocarbon Film, Jan '61, p 140, Design Show Booth No. 860.

Filled TFE Plastic, Jan '61, p 81, Design Show Booth No. 146.

Diffusion Coatings That Protect Metals to 2300 F, Dec '60, p 17, Design Show Booth No. 621.

Polypropylene Hinge, Oct '60, p 117, Design Show Booth No. 419 and Plastics Show Booth No. 1151.

Heat Resistant Epoxies, Apr '60, p 19, Plastics Show Booth Nos. 1404, 1408, 1410.

Three Urethane Foams for Thermal Insulation

Three new urethane foams have been designed for thermal insulating and cushioning applications. Two are rigid, one is flexible.

Rigid foams

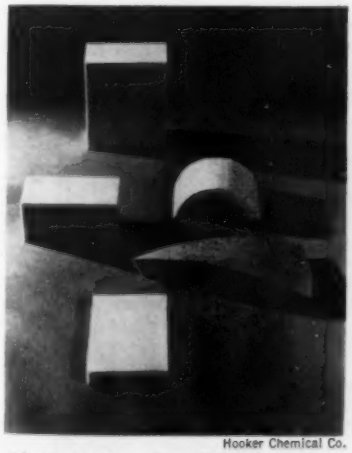
A fire retardant, rigid urethane foam developed by Durez Plastics Div., Hooker Chemical Corp., Niagara Falls, N. Y. is used in the manufacture of slab stock and molded shapes by Toyad Corp., Latrobe, Pa., under the name Chemfoam RSF.

According to Durez, the rigid foam does not distort at temperatures over 200 F. It has a k factor of 0.12 Btu/hr/sq ft/°F/in., good dimensional stability, and low water absorption.

Plastics Show Booth No. 305
M/DE KEY NO. 603

A new fluorocarbon-blown, rigid urethane foam is said to provide good dimensional stability at subzero temperatures at a density of 2 lb per cu ft. Formerly, a foam density of at least 2.5 lb per cu ft was needed for subzero applications.

Designated Lockfoam H-602, the foam is available from Nopco Chemical Co., Plastics Div., North Arlington, N. J. It is a pour-in-



Hooker Chemical Co.

Slab stock *and molded shapes are made of a new fire retardant, rigid urethane foam.*

R B&W FASTENER BRIEFS

MAKING THE MOST OF MODERN MECHANICAL FASTENING

Technical-ities

By Fred E. Graves

Fastening of joints in corrosive environment

For a fastener to stand up in a corrosive environment it must either be coated, or made from an anti-corrosive metal.

THE METALLIC COATINGS

The "workhorse" applications are satisfied most economically with SAE Grade 2 or Grade 5 fasteners. Required outdoor durability is achieved with a plated or a hot galvanized finish. Hot galvanizing complicates good thread fits, costs more than plating in the popular size range, but gives much greater protection than any commercial plating.

A heavy galvanized coating is not recommended on highly stressed fasteners. If you need the high strength of Grade 5 bolts and want them corrosion-resistant, zinc plating should be your first choice. Certain conditions may require cadmium, nickel or copper plate.

THE ENDURING METALS

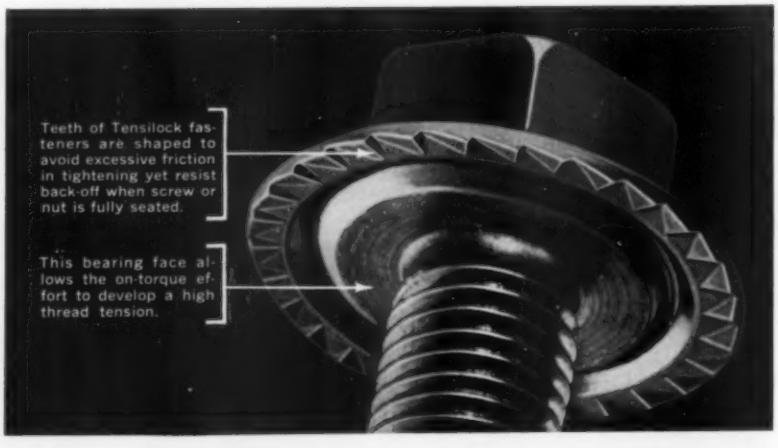
While each metal poses problems in certain applications, stainless steel, aluminum, and silicon bronze all offer distinct advantages.

Silicon bronze is popular for electrical uses due to its unusual strength, resistance to stress-corrosion, good conductivity.

Aluminum fasteners afford light weight as well as excellent conductivity. Anodized, they provide various colors; better corrosion resistance.

Widely used for fasteners, the 18-8 grade stainless steel assures good strength and excellent corrosion resistance in most atmospheres.

How Tensilock® Screws clamp tight, lock tight


Teeth of Tensilock fasteners are shaped to avoid excessive friction in tightening yet resist back-off when screw or nut is fully seated.
This bearing face allows the on-torque effort to develop a high thread tension.

TENSILOCK screws belong in the same league as high strength hex screws. With the same on-torque effort, the Tensilock units develop about 90% of the thread tension usually developed by the latter. Thus, they *both* make strong joints.

THREAD TENSION = CLAMPING FORCE

In theory, the higher the thread tension, the stronger the joint and the higher the inherent ability of the fastener to stay tight. In practice, you derive these benefits by torquing a high strength screw close to its *yield strength*. But what if you need high thread tension plus *extra* assurance that joints will stay tight? Then you have a job for Tensilock units. Not only do they develop the high thread tension, but also have an extra (and *integral*) locking device.

Screw Diameter		¼	⅜	½
Thread Tension (lbs.)	Tensilock	2,750	6,750	12,400
	High Strength Hex	2,975	7,250	13,300
On Torque (inch lbs.)	Both	120	420	1,000
Off Torque (inch lbs.)	Tensilock	150	525	1,250
	High Strength Hex	95	330	800

OFF-TORQUE = LOCKING POWER

By design, loosening torque of Tensilock fasteners exceeds tightening torque by 25% or more. This is an effective "lock." It gives that extra margin of safety against vibratory loosening.

To sum up: RB&W's Tensilock screws are stronger than Low Carbon Hex Screws; compare with High Strength Hex Screws in clamping force; are superior to them in locking action. Suggestion: For a strong locking *bolt*, use with Tensilock Nut. Send for Bulletin TL-2. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

Plants at: Port Chester, N. Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. **Sales office and warehouse at:** San Francisco, Calif. **Additional sales offices at:** Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas.

AT THE DESIGN SHOW, bring your fastening problems to R B & W, BOOTH 937

For more information, turn to Reader Service card, circle No. 506

place foam formulation with a k factor of 0.13 Btu/hr/sq ft/°F/in. The cell walls of Lockfoam H-602 do not collapse at subzero temperatures as do those of conventional fluorocarbon-blown foams.

The new foam is expected to be used as a thermal insulation in refrigerators, freezers, frozen food lockers, refrigerated warehouses, highway trailers and refrigerated railway cars.

Plastics Show Booth No. 851
M/DE KEY NO. 604

Flexible foam

A flexible urethane foam is available from Scott Paper Co., Foam Div., Chester, Pa. in a variety of shapes and densities. The foam is said to have good permeability, made possible by a three-dimensional structure of interconnecting strands. These strands are said to keep the foam open and breathable even in fine pore sizes. The new foam is expected to be used for filtering, insulating and cushioning applications.

(For more late information on urethane and other plastics foams, see M/DE, Mar '61, p 119.)

Design Show Booth No. 1112
M/DE KEY NO. 605

New Plastics: Heat Resistant Prepreg

Three new plastics—a prepreg ablation material, a high strength molding compound and prepreg glass rovings—have been introduced recently by Minnesota Mining & Mfg. Co., Chemical Div., 900 Bush St., St. Paul 6, Minn. All three materials are sold under the tradename Scotchply.

Type XP-202 is a prepreg ablation material that consists of a new carbonaceous-type fiber and a filled, modified phenolic resin. The material is said to withstand extremely high temperatures. It is expected to be used for missile nose cones, rocket nozzles and shrouds. The prepreg is available in pilot plant quantities as resin-coated rolls or chopped fabric. It sells for $28 per lb.

M/DE KEY NO. 606

Type 1100 is a glass-reinforced molding compound with a flexural strength of 65,000 psi. The producer says that an exclusive coating process results in uniform flow of the compound during molding and precise uniformity of glass-resin distribution in the finished part. The compound sells for $3.30 per lb. M/DE KEY NO. 607

Type XP-199 is prepreg glass rovings for filament winding of high strength missile and aircraft parts. The rovings have a controlled resin-glass ratio.

M/DE KEY NO. 608
Plastics Show Booth No. 1438

Alloy Steel Bars Have High Strength

Two new alloy steel bars have been added to a line of carbon steel bars produced by elevated temperature drawing, a modification of cold drawing in which the bar is worked in the 200 to 1200 F temperature range (M/DE, Mar '59, p 98).

The new materials, known as e.t.d. 150 and e.t.d. 180, are AISI 4100 series with 0.40% min carbon. They are available from La Salle Steel Co., 1420 150th St., Hammond, Ind.

No. 150 has a minimum guaranteed tensile strength of 150,000 psi (min) and a guaranteed Rockwell hardness of C32 (min) No. 180 has a guaranteed tensile strength of 180,000 psi (min) and a guaranteed Rockwell hardness of C38 (min).

The producer says parts made of the two alloy steel bars require no heat treatment; thus costs associated with heat treating, cleaning and straightening can be reduced or often eliminated.

The steel bars are said to machine faster than conventional heat treated steel bars and compare favorably with annealed, cold drawn AISI 4140 in machinability. The bars have been successfully roll threaded, and provide satisfactory finish and tool life.

Design Show Booth No. 563
M/DE KEY NO. 609

Two Electrical Laminates Meet NEMA Specs

Two new plastics laminates for electrical applications have been introduced recently by Continental-Diamond Fibre Corp., Newark, Del. One laminate is an epoxy-glass type and the other is a phenolic-paper type.

1. Epoxy-glass laminate

The epoxy-glass laminate is said to combine flame retardancy with good cold punching and machining qualities. According to the producer, the laminate is better than conventional epoxy-glass laminates in its resistance to attack by hot trichloroethylene vapors.

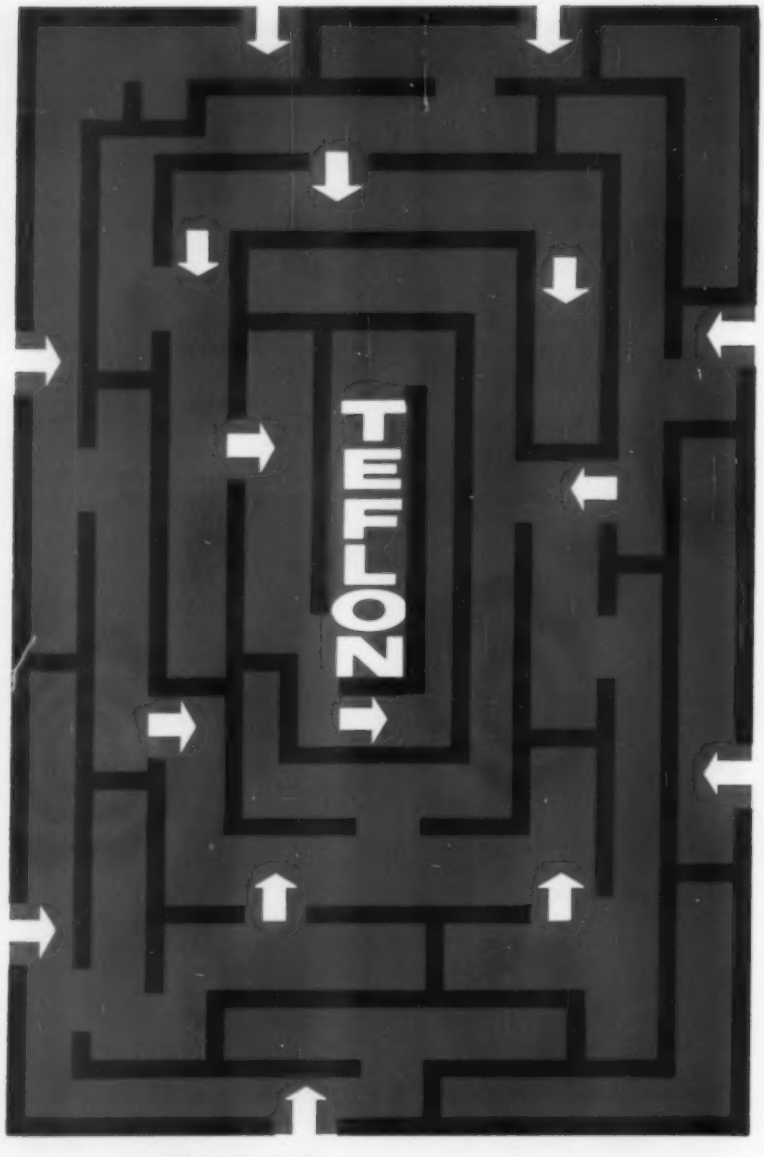
The new grade is offered copper-clad as Di-Clad 614 and unclad as Dilecto 614.

The laminate meets NEMA (National Electrical Mfrs. Assn.) specifications for G-10 and FR-4 grades. It also meets military specification MIL-P-13949B, Type GF. (Properties are given in an accompanying table.)

M/DE KEY NO. 610

2. Phenolic-paper laminate

The phenolic-paper laminate, called Dilecto 2450, meets NEMA requirements for both Grade XP



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Avoid all the detours and blind alleys which might be encountered in a haphazard search for the answer to your questions on cost, design and performance. The experienced SPARTA engineers are TEFLON EXPERTS, and will assist you with the most direct route to the heart of your problem.

TEFLON*IS OUR ONLY BUSINESS! After a thorough analysis of your requirements we will tell you definitely whether or not TEFLON is the answer for your application. If it is not, we will tell you that too, avoiding any further lost time.

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A wide variety of standard TEFLON shapes, such as tubing, rod, sheet, tape, molded billets and "O" rings are always available.

SPARTA **manufacturing company, dover, ohio**

DIVISION OF UNITED STATES CERAMIC TILE COMPANY

TWX—STBG-069

*Du Pont trademark for its TFE-fluorocarbon resin

For more information, turn to Reader Service card, circle No. 455

WHAT'S NEW

AT THE SHOWS

PROPERTIES OF DI-CLAD 614*

MECHANICAL PROPERTIES	
Tensile Strength, psi	
Lengthwise	55,000
Crosswise	45,000
Flexural Strength, psi	
Lengthwise	75,000
Crosswise	67,000
Compressive Strength (flatwise), psi	55,000
Impact Strength (edgewise), ft-lb/in.	
Lengthwise	13
Crosswise	11
Rockwell Hardness	M100
ELECTRICAL PROPERTIES	
Dielectric Strength (perp., short time), v/mil	600
Insulation Resistance (cond C96/35/90), megohms	200,000
Arc Resistance, sec	130
Dielectric Constant (1 mc, cond A)	4.8
Dissipation Factor (1 mc)	
Cond A	0.04
Cond D24/23	0.05

*Tests performed on 1/16-in. thick sheet.

and Grade X. It can be readily hot punched into intricate shapes for electrical and mechanical applications. The laminate is said to have low water absorption.

M/DE KEY NO. 611

Design Show Booth Nos. 156, 158

Adhesives for Bonding Honeycomb, Circuits

A structural thermosetting film adhesive, a series of printed circuit adhesives, and a series of contact bond adhesives are available from Minnesota Mining & Mfg. Co., Adhesives, Coatings and Sealers Div., 900 Bush Ave., St. Paul 6, Minn.

Film adhesive: The thermosetting film adhesive, designated AF-110, can be used for low pressure bonding, requiring only enough pressure during the curing operation to provide contact between the parts being bonded and to keep them properly aligned.

According to 3M, the adhesive exceeds the requirements of military specification MIL-A-5090D Type I for metal-to-metal bonding and MIL-A-25463 Type I, Class 2 for honeycomb sandwich construction.

The adhesive provides metal-to-metal shear strengths over 4000 psi at 75 F. It is said to have excellent resistance to vibration and shock,

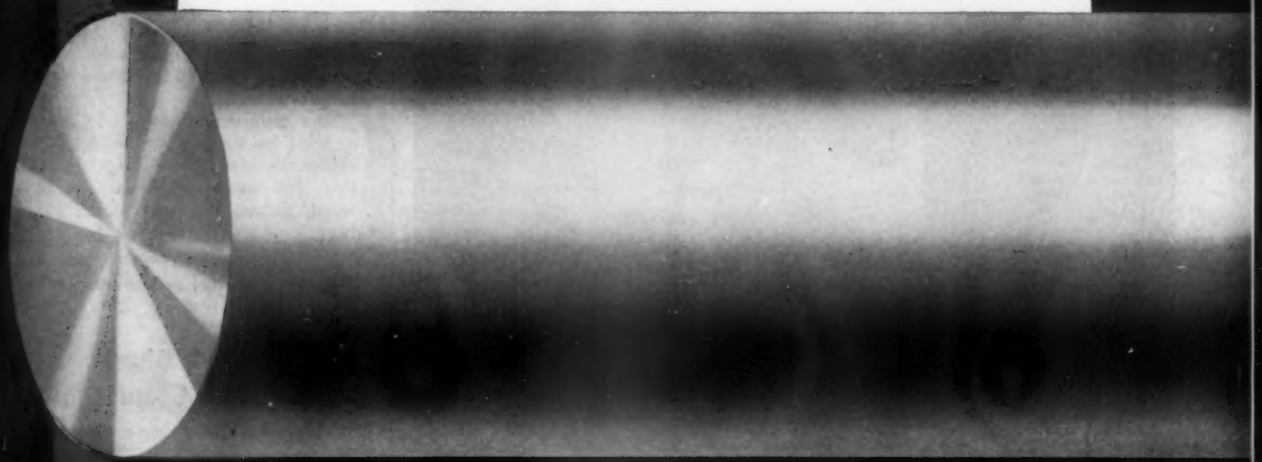
Application tested! Proved!

WHY HEAT TREAT PARTS? use e.t.d. 150

elevated temperature drawing (150,000 psi tensile)

ALLOY STEEL BARS

- **e.t.d. 150 Alloy needs no heat treating!**
- **e.t.d. 150 Alloy has 150,000 psi tensile guaranteed! (Rockwell C32 minimum)**
- **e.t.d. 150 Alloy machines better than heat treated alloy steels!**



Here are cost-reducing advantages

(1) Heat treating problems, costs (and secondary operations) are eliminated. (2) "e.t.d." 150 machines better than heat treated in-the-bar alloy steels. (3) Tool life and finish are excellent. (4) No quench cracks or distortion from heat treatment. (5) "e.t.d." 150 has exceptional strength and hardness uniformity across the bar. (6) End cost of parts is greatly reduced.

Use this coupon to request Helpful Data Bulletin 22.

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1418 150th St. Hammond, Ind.

Manufacturers of STRESSPROOF®, FATIGUE-PROOF®, and a complete line of cold-finished steel bars.

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Title_____

Company_____

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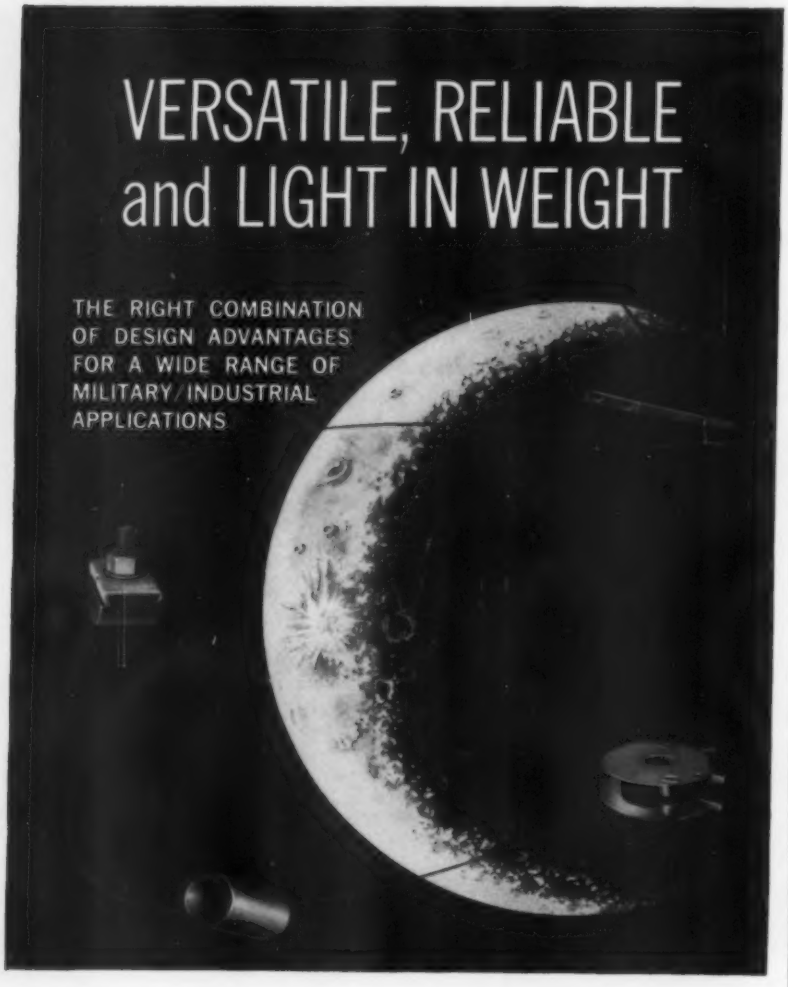
For more information, turn to Reader Service card, circle No. 439

Morganite Self-Lubricating Fine Carbon Graphites...



- Immune to Chemical Attack
- High Reliability to 1000°F in Oxidizing Atmosphere
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- Resists Thermal Shock
- Light in Weight—Exceptionally Easy to Mold
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MORGANITE is specified industry-wide for thousands of applications including seals, bearings, pump vanes, meter valves, electrical contacts and special mechanisms. This universal material functions efficiently in oil, grease, grit — under high pressure, at high temperatures. MORGANITE is ideal for use in sealed mechanisms and is employed in many vital missile and "space age" projects. Call or write for design criteria, or ask MORGANITE for recommendations on your specific applications.

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Manufacturers of Fine Carbon Graphite Products including Mechanical Carbons, Motor and Generator Brushes, Carbon Piles, Current Collectors and Electrical Contacts – Distributors of 99.7% Pure Al_2O_3 Tubes, Crucibles and Crusilite Electric Heating Elements.

3324 48th Avenue, Long Island City 1, New York

In Canada: Morganite Canada Ltd., Toronto

For more information, turn to Reader Service card, circle No. 325

WHAT'S NEW

AT THE SHOWS

and to exposure from water, oils, fuels and salt spray.

M/DE KEY NO. 612

Printed circuit adhesives: The printed circuit adhesives are designed for bonding copper foil to phenolic-paper, epoxy-paper and epoxy-glass laminates. A number of adhesives have been developed to meet individual requirements since no single adhesive will meet the material, production and bonding requirements of all printed circuit manufacturers.

M/DE KEY NO. 613

Contact adhesives: The series of contact bond adhesives can be applied to parts before bonding. When parts are to be bonded, only momentary pressure is required to effect a strong bond.

The contact adhesives are recommended for bonding sandwich panels, rubber weatherstrip, fabrics to metal, metal to metal, aluminum to plywood, nameplates and metal moldings.

M/DE KEY NO. 614
Design Show Booth No. 560

Rigid Vinyl Sheet Is Crystal Clear

A crystal clear, rigid vinyl sheet is now available in pilot plant quantities from Nixon-Baldwin Chemicals Inc., Nixon, N. J.

The extruded sheet is said to have excellent clarity, good formability and good chemical resistance. It is dimensionally stable, contains no plasticizer, does not support combustion, and does not warp.

Sheet thickness of the extruded vinyl ranges from 5 to 80 mils. Maximum width is 26 in. at present, to be extended up to 48 in. later this year.

The sheet can be formulated with ultraviolet or anti-static inhibitors.

Plastics Show Booth Nos. 407, 409
M/DE KEY NO. 615

Brazing Alloy Pastes Are Easy to Apply

A series of nickel-chromium-boron brazing alloys are available in a new form to promote speed and ease of application. The new form is a mixture of alloy powders in a high viscosity vehicle.

The developer is Wall Colmonoy

Bethlehem engineers redesigned these cost-saving specials.

Steel

for Strength
. . . Economy
. . . Versatility

Each of these special fasteners was redesigned to do a better job. And each represents a reduction in cost for the customer. Bethlehem's fastener engineers were able to come up with improved designs to solve a specific problem.

Perhaps a fastener you are now using should be studied to see if its redesign could cut your costs. Just send us a sample of the part, or a drawing or sketch of what you need. Maximum results will be obtained when you supply a detailed description of the end use.

Our fastener engineers will look it over and give you an honest appraisal of what can be done. Call the nearest Bethlehem sales office. Or write to us at the address below.

BETHLEHEM STEEL COMPANY, Bethlehem, Pa. Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

For more information, turn to Reader Service card, circle No. 411

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TOUGH paper for toughest jobs— Mosinee SCRIMTEX

- Made with ¼" or ½" mesh scrim of rayon or fiberglass —an integral part of paper and *not a laminate.*
- For heavy-duty jobs—multi-wall bags, car liners, envelopes, saturating, tarpaulins, wrappings, packaging materials, plastic reinforcement, etc.
- Scores high in puncture, tensile and tear tests. Remains strong at temperatures from −75° F. to +425° F.
- You can print on it, coat it, laminate it or impregnate it.
- Uniform quality—from roll to roll . . . from carload to carload.

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FREE—DATA FILE AND PAPER TERMS DICTIONARY
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For more information, turn to Reader Service card, circle No. 372

WHAT'S NEW
AT THE SHOWS

***Applying** Ni-Cr-B brazing alloy in new paste form.*

Corp., 19345 John R St., Detroit 3. Designated Nicrobraz S, the alloys are applied by air gun for production work or by manual syringe for smaller jobs.

Design Show Booth No. 1234
M/DE KEY NO. 616

Investment cast pin—A cost saving of 50% was achieved on this small silicon brass pin by using investment casting rather than conventional screw machining techniques. According to Hitchiner Mfg. Co., Inc., Milford, N. H., investment casting permitted making the part to close dimensional tolerances and eliminating all secondary finishing operations.

The pin is a precision part less than 1½ in. long with an eccentric collet and several teeth in a cam. The teeth were blanked when the part was made on screw machines. Burrs and broken teeth caused a high rejection rate.

Design Show Booth No. 1025

Pearl Pigments Give Multiple Color Effects

A series of improved synthetic pearl pigments are said to produce multiple color effects in plastics parts and coatings. For example, a polyester cast sheet containing a red pig-

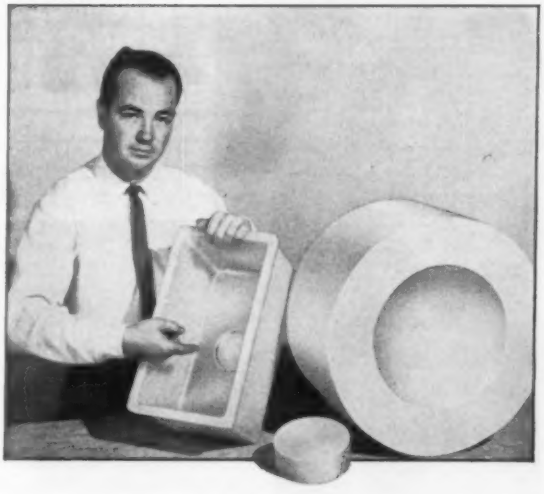
EXTRUSION SPECIALISTS

Profiles · Sheet · Moldings

Compounding to meet specific design requirements in Vinyls, standard and linear Polyethylene, Teflon 100, Nylon, Polypropylene, Polystyrene, Styrene rubber co-polymers and others

Complete technical facilities, our own die shop, a wide range of extruder types and sizes, and rigid quality control standards, enable Conneaut to deliver quickly top-quality extrusions, competitively priced.

We can, for example, provide plastic sheet, either rigid or elastomeric, for fabrication by heat welding or vacuum forming, in gauges from .025" to .250" in various widths. We can furnish extrusion molded slugs up to several hundred pounds for further machining in your plant or we can furnish the final part machined to your specifications. Formulations can be varied to meet design requirements. For nuclear applications, additives such as elemental boron, boron carbide, lead oxide or cadmium oxide can be incorporated. We can furnish profiles in any extrudable cross-section to extremely close tolerances and hold the tolerances through the length of the run. If desired, we can heat-seal, punch or otherwise fabricate the extruded profile to your specifications.



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Quickly, Accurately, Economically

Write, wire, or phone 51-961, Conneaut, for prompt information, project analysis, recommendations or quotations.

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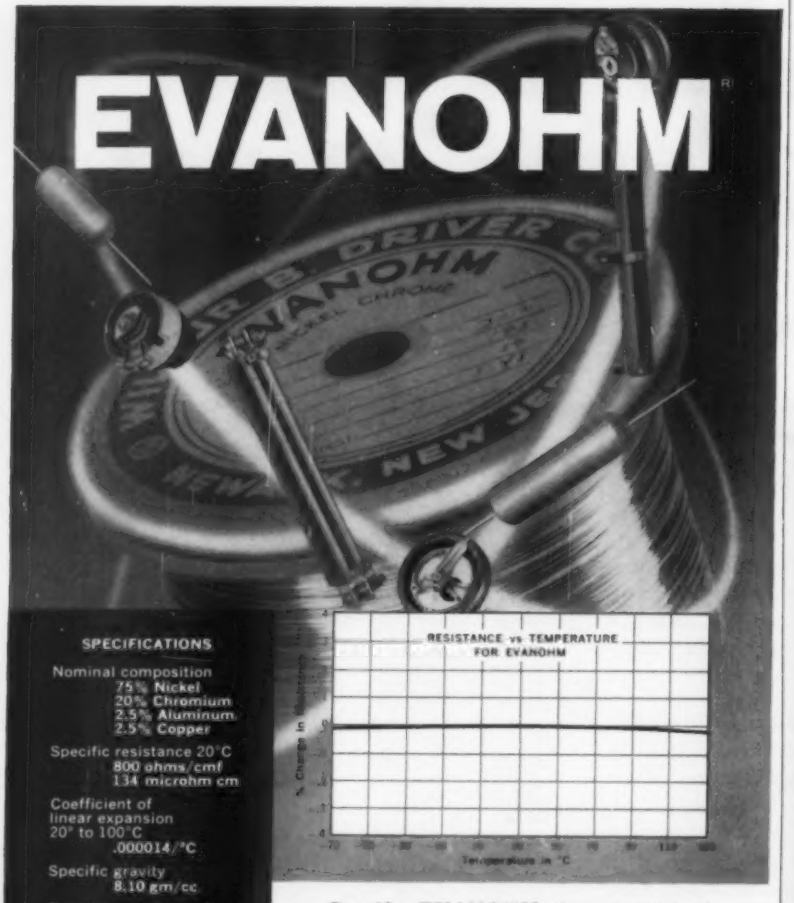
For more information, turn to Reader Service card, circle 431

Time-tested Standard of the Resistor Industry!



SPECIFICATIONS

Nominal composition
75% Nickel
20% Chromium
2.5% Aluminum
2.5% Copper

Specific resistance 20°C
800 ohms/cmf
134 microhm cm

Coefficient of linear expansion 20° to 100°C
.000014/°C

Specific gravity
8.10 gm/cc

Pounds per cubic inch
.293

Magnetic attraction
None

Average tensile strength
180,000 psi

Thermal conductivity
0.152 W/cm/°C

Mean thermal EMF vs copper 0°C to 100°C
1 μv/°C

Specify EVANOHM for exceptional stability over wide temperature ranges. This WBD precision resistance alloy provides high specific resistance, low temperature coefficient and low thermal EMF to copper. It is especially recommended for high reliability applications . . . resistors, precision instruments, missiles and critical equipment. Available in bare wire, enameled or insulated.

FINE WIRE ALLOYS IN A FULL RANGE OF RESISTIVITIES

ALLOY	Nominal Composition	Resistivity (ohms/cmf)	T.C. of Resistance (ohms/ohm/°C, 20-100°C)	Specific Gravity gms/cc
Evanohm®	75 Ni-20 Cr-2.5 Al-2.5 Cu	800	±.000005† (−65° to 125° C.)	8.10
Tophet A®	80 Ni-20 Cr	650	.000085	8.412
Tophet® C	61 Ni-15 Cr-bal. Fe	675	.00013	8.247
Cupron® (Constantan)	55-Cu-45 Ni	294	±.000020	8.90
Balco®	70 Ni-30 Fe	120	.0045	8.46
Ballast® (Pure Nickel)	99.7 Ni	48	.0060	8.90
30,60,90,180 Alloys	Cu-Ni	30-180	.00130 - .00018	8.90

†.002" and finer

Call or write for EVANOHM brochure to—

WILBUR B. DRIVER COMPANY
NEWARK 4, NEW JERSEY — Telephone: HUmboldt 2-5550

In Canada: Canadian Wilbur B. Driver Co., Ltd., 50 Ronson Drive, Rexdale (Toronto)

PRECISION RESISTANCE, ELECTRONIC AND MECHANICAL ALLOYS FOR ALL REQUIREMENTS

For more information, turn to Reader Service card, circle No. 391

WHAT'S NEW
AT THE SHOWS

ment appears red when held against a dark background and examined by reflected light. When viewed by transmitted light, however, the complementary green color is observed.

The pigments, called Murano, are available in a range of colors from Mearl Corp., 41 E. 42nd St., New York 17. They are supplied in formulations for use with most coating vehicles and plastics.

Plastics Show Booth No. 213
M/DE KEY NO. 617

Alloy steel castings—An estimated 250% increase in service life has resulted from use of these shell mold cast, high alloy nozzle heads, according to the Alloy Casting Institute. The cast stainless steel nozzle head blanks are said to be less costly than previously used wrought fabricated parts and require less machining. The nozzle heads were made by Copes-Vulcan Div. of Blaw-Knox Co.

Design Show Booth No. 329

Three New Fasteners Are Easy to Install

Three new fastener designs are said to provide ease of assembly and high holding power.

1. Knurl bolt

A new bolt now available from Lamson & Sessions Co., 5000 Tiedeman Rd., Cleveland 9, Ohio has a

For more information, circle No. 344 ➤

Diffusers molded by Flambeau Plastics Corp., Baraboo, Wisconsin

A new concept in air distribution—pioneered by Carnes Corporation of Verona, Wisc.—made a reality by LEXAN polycarbonate resin!

In Carnes' design, 6-by-6-inch air diffusers, like those above, form modular units which can be arranged in any desired ceiling pattern. Three different module designs provide complete flexibility in directing air.

"LEXAN resin is the only material we have approved for our diffusers," says Gordon Sylvester, Chief Product Engineer of Carnes. "We tried polystyrenes, polyethylene, nylon and others, but they all fell short in one way or another."

The material for Carnes' diffusers had to meet this combination of requirements: • INJECTION MOLDING for low production cost. LEXAN resin, as a thermoplastic, gave this advantage. • NO HEAT DISTORTION in 225°F. test for handling warm air. In month-long tests of parts, LEXAN resin met this spec. Actually, the resin's rated distortion point is 270-280°F. under load. • DIMENSIONAL STABILITY in use. LEXAN resin was stable. • FLAME RETARDANCE to pass ASTM test. LEXAN resin passed. • COLOR STABILITY and versatility. Although the modules are now a stable white, LEXAN resin offers the possibility of a wide range of colors. • HIGH IMPACT RESISTANCE. Frank Freese, Product and Merchandising Manager for Carnes, really sells LEXAN resin's enormous impact strength. He says "In demonstrating the strength of the modules, we slam them against the wall. It doesn't damage them at all. Metal diffusers would be bent by this treatment."

LEXAN resin has raised the quality of many designs to new levels. It's been substantially reduced in price as new G-E plant facilities have come onstream. Can this tough new thermoplastic help you? Send for design literature. Address General Electric Company, Chemical Materials Dept., Section M-51, Pittsfield, Mass.

LEXAN®
Polycarbonate Resin
GENERAL ELECTRIC

"the birth of
an alloy"
Waukesha's research induction furnace provides sample heats formulated to meet all your casting requirements . . . at only a fraction of the cost involved in a full foundry test run.

WAUKESHA CASTINGS

From created alloys . . .

Pressures . . . corrosion-resistance . . . stability under extreme temperature variables . . . increased tensile strengths . . . only castings of created alloys can fulfill all the precise requirements of space-age technology. In less than a decade, Waukesha Foundry Company has created 5 corrosion-resistant non-galling metals.

From blueprint to finished casting, Waukesha follows your precise requirements. Facilities include "Spectrometer" control with each heat, pilot plant facilities, sand, shell and ceramic-type moldings, fully equipped finishing and polishing shop. The metallurgical staff assigned to create the alloy for your product offers over half a century of experience with created metals.

Where precision engineered castings are an absolute requirement, call on Waukesha.

VISIT US AT THE DESIGN ENGINEERING SHOW, BOOTH NO. 616

Waukesha Foundry Company

WAUKESHA FOUNDRY CO.
Dept. F 19, Waukesha, Wis.

Manufacturers of corrosion-resistant castings, inclusive of non-galling alloys, Stainless Steel, Waukesha Metal, Monel, Pure Nickel, Inconel, Ni-Resist, plus special Nickel-Chromium Alloys for specific applications.

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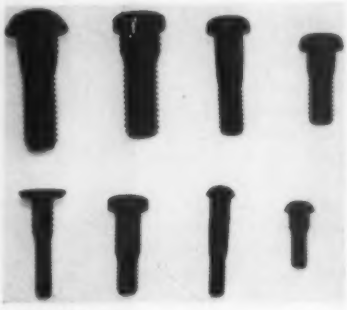
WHAT'S NEW

AT THE SHOWS



Knurl bolt

shank with rows of formed knurls which produces a tight fit in the connected material. The length of knurled body is determined by the thickness of the members to be joined. The bolt is said to provide the following advantages:

1. Easier and more economical assembly than conventional bolts: the bolt head does not have to be held while assembling the nut.
2. Cannot be pushed out of the hole during nut assembly.
3. Better electrical grounding than conventional bolts.

Design Show Booth No. 140
M/DE KEY NO. 618

2. Clinch nut

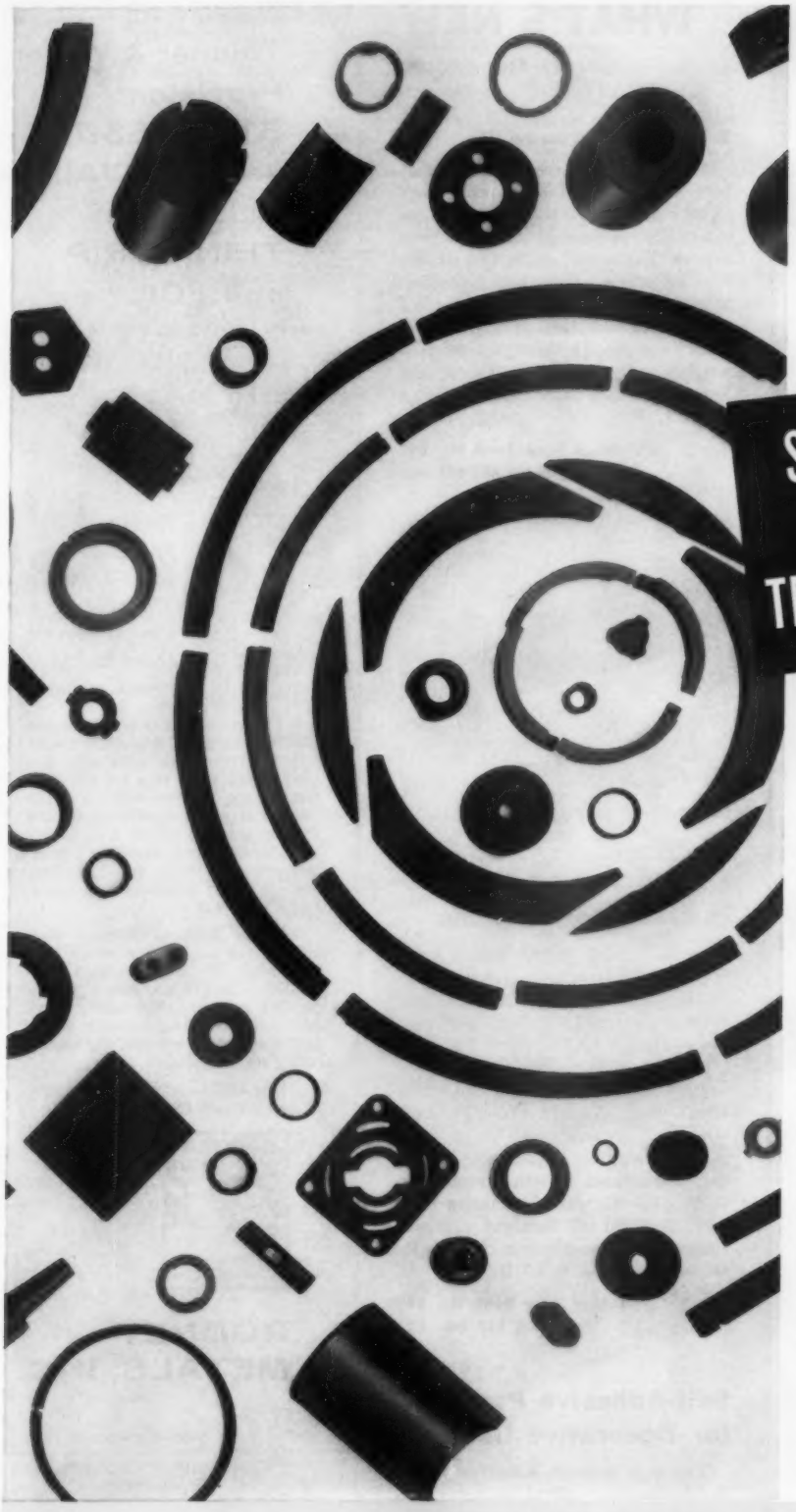
Greater tolerances for mating assemblies and simplified installation are the important advantages offered by a new floating clinch nut design introduced by Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N. J.

Clinch nut

The nut, called Type NC4284, automatically compensates for minor bolt hole misalignment of parts being joined. The self-locking nut is made in carbon and 18-8 stainless steels in machine screw sizes Nos. 4, 6, 8, 10.

Design Show Booth Nos. 720, 726
M/DE KEY NO. 619

(continued on p 198)



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*CARBON-GRAPHITE ESPECIALLY DESIGNED FOR MECHANCAL APPLICATIONS

Sliding or rotating components compounded and molded of ***PUREBON*** are unusually stable at high temperatures, self-lubricating and light in weight. Further, this material is chemically inert, moldable to size and readily machinable . . .
Try ***PUREBON!***

Request Catalog #60 or see Sweet's Product Design File

PURE CARBON CO., INC.

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For more information, turn to Reader Service card, circle No. 339

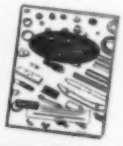
RULON® AND TEFLON®

RULON'S "Plastic Memory" Means Tighter Seals . . . Lower Costs

RULON (reinforced TFE) parts post-formed from tape are ideal for seals, packings, rings, etc. because they exhibit no stick-slip and greatly reduce starting torque. And unlike rubber or leather, RULON takes any hydraulic fluid – and its plastic memory insures positive contact with shafts or cylinder walls. Parts have infinite shelf life, too – completely unaffected by weather, light or heat.

Dixon's self-lubricating RULON gives your sealing applications all the advantages of Teflon – low friction, chemical inertness, zero moisture absorption, extreme temperature range (−400 to +500°F) – PLUS a tremendous increase in mechanical strength and wear resistance.

Next time, look at your design with RULON in mind. This material is now available with improved sealing action and at costs competitive with leather and rubber. For complete data on stamped or post-formed parts . . . special reinforced fluorocarbons for special needs . . . and a wide selection of basic shapes in both RULON and Teflon . . . see our Catalog in Sweet's Product Design File, or write for Brochure #9572. DIXON CORPORATION, 102 BURNSIDE ST., BRISTOL, R. I.



* DuPont T.M.

DIXON

For more information, circle No. 425

WHAT'S NEW

AT THE SHOWS

3. Counterbore screw

An externally wrenched counterbore screw is said to wrench down tighter and faster than conventional internally wrenched socket head screws. The screw, called Countr-bor, fits in standard socket wrenches. Made of high strength, heat treated alloy steel, the bolt is supplied in sizes from No. 10 through 1 in. It is available from Ferry Cap & Set Screw Co., 2151 Scranton Rd., Cleveland 13, Ohio.

Design Show Booth No. 809
M/DE KEY NO. 620

Counterbore screw

Finned Tubing for Nuclear Applications

Straight and spiral finned tubes for fuel elements and heat exchangers in nuclear reactors are available from Superior Tube Co., 1548 Germantown Ave., Norristown, Pa. Both types of tubing are made in austenitic stainless steels, nickel and nickel alloys, and titanium and zirconium alloys.

The straight and spiral finned tubing is produced in sizes from ¼ to ½ in. o.d. with wall thicknesses from 0.030 to 0.060 in. Straight tubing is supplied in lengths up to 24 ft; spiral tubing up to 10 ft.

Design Show Booth No. 849
M/DE KEY NO. 621

Self-Adhesive Papers for Decorative Uses

Two new pressure-sensitive papers for decorative applications have been placed on the market recently.

One paper is available from Avery Label Co., 117 Liberty St., New York City in a variety of colors, styles and embossed patterns. The self-adhesive

Need Thinner & Wider Precision STAINLESS and SPECIAL ALLOYS in THIN STRIP and FOIL?

Rodney Specializes in Close-Tolerance Thinness . . . Unique Service Described in Free Catalog!

Rodney concentrates its entire efforts, research and production, toward furnishing super thin, extra wide, precision rolled, metal strip and foil in all tempers and finishes. With the entire capacity of plant and personnel devoted exclusively to this specific area, Rodney can offer the added "know-how", manufacturing experience, quality control, and application knowledge your operation may require.

Rodney produces stainless steel strip . . . all alloys . . . in widths from ⅛" to 24" . . . at gauges from .012" to .0003". Rodney also rolls high temperature alloys and other special alloys on a production basis. Aluminum alloys, carbon steel strip and specialty custom rolling are also handled.

FREE FACTS . . . just drop us a note on your company letterhead.

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West Coast Office & Warehouse:
5462 East Jillson St., Los Angeles 22, Calif.

For more information, circle No. 456

NEW 15-MINUTE X-RAY OF AN ALLOY MEANS STILL HIGHER QUALITY...

STILL FASTER SERVICE FROM C-M. HERE'S THE RESULT OF A GREAT NEW ADVANCE IN QUALITY CONTROL — A COMPLETE ALLOY ANALYSIS ON PRINTED TAPE OBTAINED WITH THE UNIQUE NEW X-RAY SPECTROGRAPHIC PROCESS. THIS NEW METHOD BENEFITS YOU TWO IMPORTANT WAYS: FIRST, IT MAKES ALLOY ANALYSIS MORE ACCURATE THAN EVER BEFORE . . . WHICH MEANS ADDED CERTAINTY THAT YOUR ALLOYS ADHERE RIGIDLY TO QUALITY SPECIFICATIONS. ALSO, THIS NEW X-RAY PROCESS MAKES THE COMPLETE ANALYSIS IN JUST 15 MINUTES INSTEAD OF 3 DAYS. TOTAL RESULT: STILL HIGHER QUALITY, BETTER SERVICE, FASTER DELIVERY. A POST CARD BRINGS FULL INFORMATION.

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CANNON-MUSKEGON CORPORATION

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PRODUCERS OF IRON, NICKEL AND COBALT ALLOYS: SHEET, WIRE, BAR, FORGINGS, INGOTS, SHOT

For more information, turn to Reader Service card, circle No. 501

CONTEMPLATE SOMERS THIN STRIP FIRST

Somers provides the most durable, dependable material for a wide range of electronic, electrical, aircraft, missile and many other applications.

For accuracy in dimension, physical and chemical properties on metal from .010" to .000125 thin (nickel alloys from .020"), consult Somers — over 50 years the number one source.

Brass	Stainless Steel
Copper	Phosphor Bronze
Nickel	High Temperature Metals
Monel	Beryllium Copper
Inconel	Glass Sealing Alloy
Inconel X	Tin Coated Metals
Nickel Silver	and Rare Metals

Write for confidential analysis of your specific requirements — no obligation, of course.

Somers THIN STRIP

THE SOMERS BRASS CO., INC., WATERBURY, CONN.

Phone (Area Code — 203) PLaza 4-8331 TWX-WBY77

For more information, turn to Reader Service card, circle No. 405

WHAT'S NEW

AT THE SHOWS

plastics-coated paper is said to cost about 40 to 50% less than comparable pressure-sensitive vinyl materials and about 30% less than polyester materials.

The producer says the paper is washable, durable and grease resistant. It is recommended for use on clock faces, picture frames, book bindings and wastepaper baskets.

Design Show Booth No. 905
Plastics Show Booth No. 210
M/DE KEY NO. 622

The other self-adhesive paper is available from Fasson Products Co., Painesville, Ohio. It is designed for protecting highly polished surfaces such as buffed stainless steel and aluminum. The paper is translucent and markable, permitting directions, designs or names to be seen through or written on it.

Design Show Booth No. 416
M/DE KEY NO. 623

Other Show News . . .

▸ New sizes of electric resistance welded steel tubing have been announced by Ohio Seamless Tube Div., Copperweld Steel Co., Shelby, Ohio. The tubing is available in sizes up to 7½ in. o.d. by 0.375-in. wall thickness in round shapes; up to 6 by 6 by 0.259 in. in square shapes; and up to 7½ in. dia by 0.259 in. wall thickness in rectangular shapes. The tubing is supplied in mechanical and pressure grades.

Design Show Booth Nos. 811, 813
M/DE KEY NO. 626

▸ Close tolerance balls made of Delrin acetal resin and Lexan polycarbonate resin have been introduced by Industrial Tectonics, Inc., 3686 Jackson Rd., Ann Arbor, Mich.

Design Show Booth No. 1000
M/DE KEY NO. 628

▸ Reinforced plastics moldings in a variety of formulations, colors, shapes and sizes to meet specific product requirements are available from Cimastra Div., Cincinnati Milling Machine Co., Cincinnati 9, Ohio.

Plastics Show Booth No. 840
M/DE KEY NO. 630

▸ A fabric-backed urethane rubber sheet is recommended for use as a liner in applications where abrasion and wear is a problem. The sheet measures 40 by 96 in. and is supplied in thicknesses of 1/16, 1/8 and 1/4 in. It is available from Auburn Mfg. Co., Pease Ave. & Stack St., Middletown, Conn.

Design Show Booth No. 540
M/DE KEY NO. 632

meet the complete family

of special Vanadium-Alloys

Plastic mold steels

a grade for each specific mold requirement!

MC (Mold and Cavity)

Supplied annealed—or heat treated to 300 Brinell with high core hardness even in sizes to 20 x 10 inches. When carburized and oil quenched, provides high surface hardness.

Ni-Mold

A low carbon, chrome-nickel steel for cavity work when carburized surfaces are desired with exceptionally high core toughness.

Speed-Cut 300

Free machining, medium-carbon steel preheat-treated to 300 Brinell. Recommended for mold parts such as backing plates, cavity plates and spacer blocks.

Hotform V

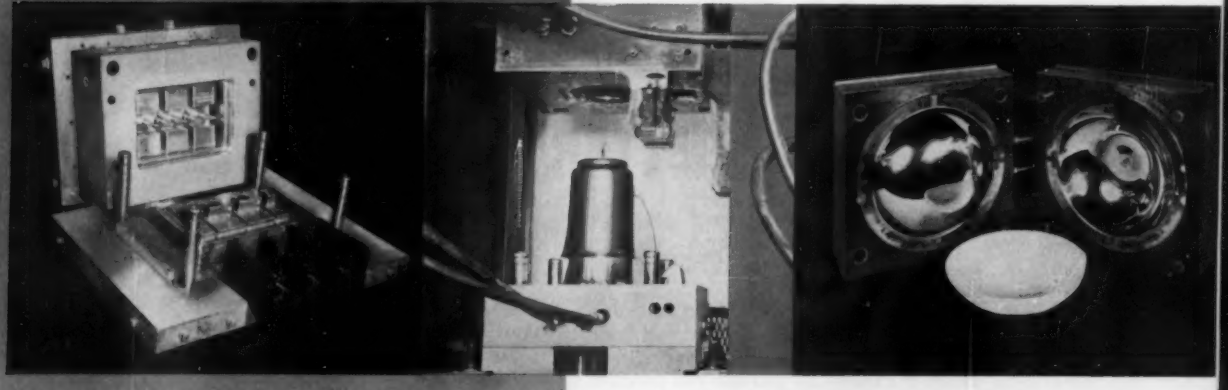
New improved Hotform "V" resists high temperatures, chromium plates with ease, is ideal for compression molding of silicone resins, etc., and long injection runs of nylon or corrosive vinyls.

Colonial No. 6

Manganese, oil hardening—closely retains size and shape after tempering. Low hardening temperature, good machinability, excellent for long runs in small cavities, either injection or compression.

Air Hard

Deep air hardening, non-deforming, good resistance to abrasive wear—valuable for compression, transfer or core molding. Intricate or complicated shapes call for this maximum-stability steel!



WRITE for new 12-page bulletin on Properties and Selection of our Plastic Die Steels—Free on request.

VANADIUM-ALLOYS STEEL COMPANY

GENERAL OFFICES: LATROBE, PA.

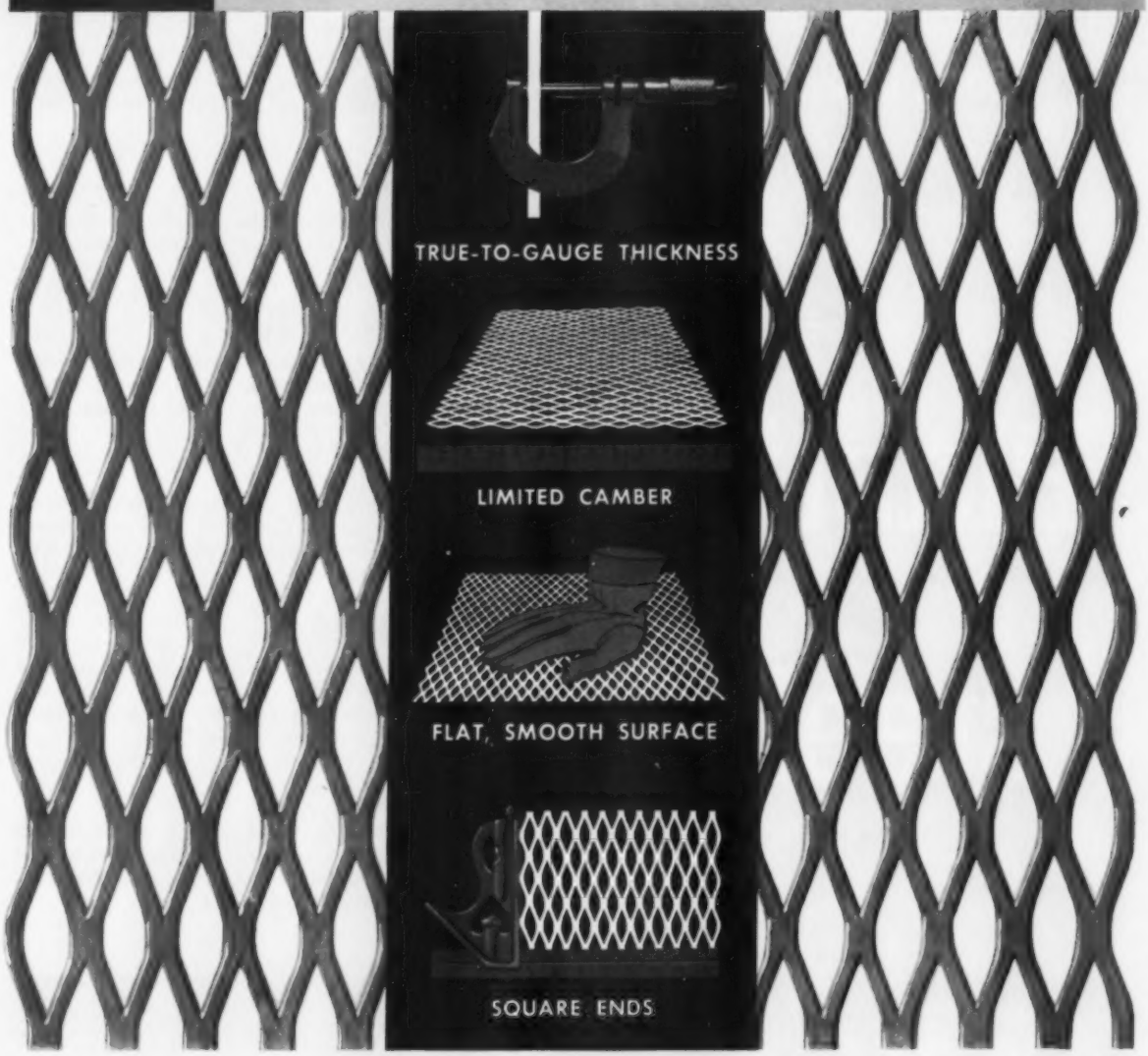
DIVISIONS: Anchor Drawn Steel Co. • Colonial Steel Co. • Metal Forming Corporation • Pittsburgh Tool Steel Wire Co. • Vanadium-Alloys Steel Co.

SUBSIDIARIES: Vanadium-Alloys Steel Canada Limited • Vanadium-Alloys Steel Societa Italiana Per Azioni • EUROPEAN ASSOCIATES: Societe Commentryenne Des Aciers Fins Vanadium-Alloys (France) • Nazionale Cogne Societa Italiana (Italy)

FIRST QUALITY TOOL & SPECIAL STEELS V-A

For more information, circle No. 381

EXPANDED METAL BY WHEELING



NOW! BETTER THAN EVER

There's a new look about Wheeling's *Flattened* Expanded Metal these days. It's smoother, more uniform than ever. So it has great, new appeal to designers and manufacturers alike!

Wheeling Expanded Metal, in both flattened and conventional styles, offers you many other advantages, too. For example, expanded metal is actually stronger than the metal from which it's made, so you can cut product weight without sacrificing product strength. And expanded metal permits free passage of light, heat and sound, so you can use it where you can't use other metals.

Get the complete story on versatile, new Wheeling Expanded Metal from your Wheeling man. Or write directly to the Wheeling Corrugating Company, Wheeling, West Virginia.

WHEELING CORRUGATING COMPANY · IT'S WHEELING STEEL!

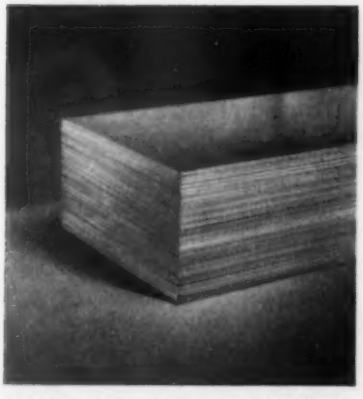
Warehouses: *Boston, Buffalo, Chicago, Columbus, Detroit, Kansas City, Louisville, Martins Ferry, Minneapolis, New York, Philadelphia, Richmond, St. Louis.* Sales Offices: *Atlanta, Houston, New Orleans.*

For more information, turn to Reader Service card, circle No. 511

OTHER WHEELING PRODUCTS:

Wheeling SofTite® Cop-R-Loy® Galvanized Sheets can withstand severe fabricating operations without flaking or peeling.

Wheeling Hot and Cold Rolled Sheets are widely known for their smooth, uniform finish. Hot and Cold Rolled Strip also available.



Wheeling Long Terne is available in widths to 48". It is normally supplied with either commercial or special terne coatings.

(cont'd from p 19)

What's new IN MATERIALS

inexpensive operation and can be accelerated by mechanical means.

Other designs, materials

Since core design is determined by the design of the core wedges, panels can also have vertically ribbed cores. The only limitation on core design is that it must be unidirectional.

Use of other metals and alloys depends on solutions to two problems:

1. Determining proper rolling techniques to insure formation of good bonds.
2. Selecting a material for the insert wedges that can be leached out without damage to the honeycomb material. KEY NO. 639

Aluminum Clad with Stainless

■ Austenitic stainless steel molecularly bonded to 1100 or 3003 aluminum alloy by a diffusion process is being produced by Fairmont Aluminum Co., Fairmont, W. Va.

Initial production of stainless-clad aluminum will go to cooking utensil manufacturers. Cooking utensils can use to advantage the corrosion resistance of both materials, combined with the strength of stainless and the high thermal conductivity of aluminum. Utensils have already passed tests ranging from thermal shock resistance to the hazards encountered in normal cooking.

Industrial applications are not being overlooked. Fairmont foresees such potential applications as liquid storage tanks, automotive parts normally made of stainless steel, and rockets and missiles.

There appear to be no limitations on thickness of the material. A typical sheet 0.050 in. thick would be clad with 0.009 in. of stainless over 0.041 in. of aluminum. Such a sheet would be half the weight of a similar 0.050-in. thick stainless steel sheet.

Workability has been tested in operations such as deep drawing, stamping, trimming, beading and spinning; arc, stud and spot welding; brazing and coining.

Stainless-clad aluminum is available in limited quantities right now. Full-scale production is expected in the latter part of this year. KEY NO. 640

Polyethylenes for Film, Blow Molded Parts

Five new polyethylene blow molding resins and two new polyethylene film-grade resins have been introduced recently by Dow Chemical Co., Midland, Mich. The blow molding resins sell for 27½¢ per lb and the film-grade resins for 32½¢ per lb in truckload lots.

1. Blow molding resins

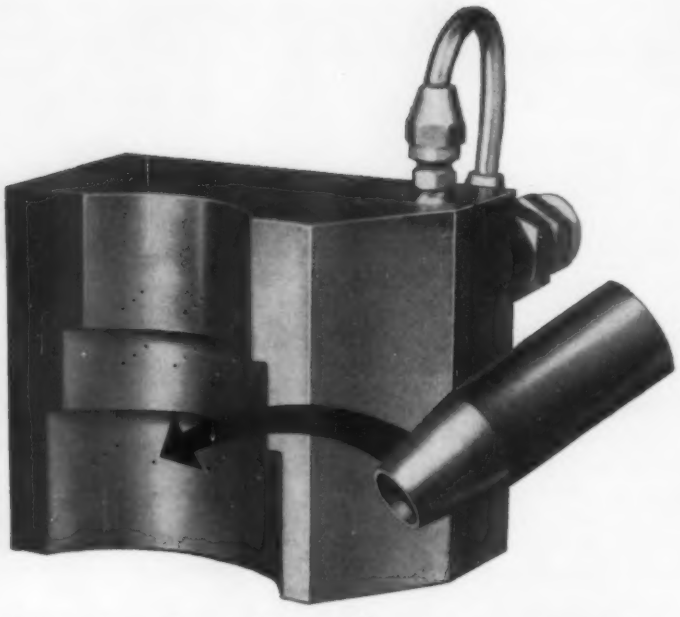
No. 410M is a general purpose resin designed for use in squeeze bottles, toys and some industrial parts. It has a density of 0.917 gm per cu cm and a melt index of 1.5.

No. 510E has excellent flow properties and can be used for squeeze bottles, tubes and toys. Density, 0.919. Melt index, 2.0.

No. 400B combines good stress crack resistance with high clarity and gloss. Density, 0.920. Melt index, 1.5.

No. 200B has good resistance to stress cracking, good flow properties and high modulus. Density, 0.923. Melt index, 0.7.

No. 550E combines high clarity



Kentanium* outlasts copper for flame hardening nozzles

. . . better than 2 to 1

An automotive parts manufacturer flame hardens crankshafts and other parts with a one to four mixture of propane and oxygen. Under pressure, the impurities present in these gases tend to erode the 36 tiny nozzles contained in each half of the flame head. Accurate control of the process depends largely upon the ability of each nozzle orifice to resist erosion and maintain original size.

With copper or steel nozzles, flame head ports had to be cleaned every 40 to 45 hours, and the nozzles scrapped after eight months. On this same application, Kentanium nozzles need to be cleaned only once every two months. And, after sixteen months, the Kentanium nozzles are operating just as accurately as the first day they were put in service.

Nozzles or valve parts, cutting edges or pressure vessels . . . Kennametal* compositions can take just about any form to solve problems of erosion, abrasion, corrosion, impact, high pressure and extreme temperatures.

SOME OUTSTANDING PROPERTIES OF KENNAMETAL COMPOSITIONS

- YME up to 94 million psi. (Compares with steel's 30 million.)
- Density range from 5.7 to over 15.0 gms/cc (Steel—7.8).
- Compositions available to resist corrosion-wear conditions encountered with nitric, sulfuric and hydrochloric acids, and sodium hydroxide.
- Extremely hard. Up to 94 Rockwell A. (Outwears steel up to 100 to 1.)
- Kentanium retains sufficient strength for continuous operation at temperatures to 2200° F. and at higher temperatures under specific conditions.

If you'd like more information, contact a Kennametal Representative or write us direct for the booklets, "Properties of Kennametal," and "Proven Uses." KENNAMETAL INC., Department MDE, Latrobe, Pennsylvania.

*Kennametal is the registered trademark of a series of hard carbide alloys of tungsten, tungsten-titanium and tantalum. Kentanium is the registered trademark of a series for applications that require a lighter weight material, or maximum resistance to temperature extremes. 33579

INDUSTRY AND KENNAMETAL ...Partners in Progress

For more information, turn to Reader Service card, circle No. 409

and high modulus with excellent processability. Density, 0.925. Melt index, 2.0. KEY NO. 641

2. Film-grade resins

No. 555E is a 0.935 density resin with a 2.5 melt index. It has high clarity, high gloss and exceptional stiffness. It is recommended for overwrap applications where machine handling is critical.

Dow says No. 555E can also be used for blow molding products requiring a high degree of stiffness while still maintaining good processing characteristics.

No. 222E is a 0.935 density material with a 0.9 melt index. Films made from the resin are said to have a satin-like surface sheen and "see-through" clarity. KEY NO. 642

Stainless Steel Solder Easy to Clean Up After

A new paste solder has been designed primarily for soldering types 304, 430 and other stainless steels. A big advantage of the solder is that residues left after soldering can be removed easily by dipping in water: solder residues on stainless steel are usually hard to remove and require special treatment.

The paste solder, called WC, is available from Fusion Engineering, 17921 Roseland Ave., Cleveland 12, Ohio. It contains an acid flux, solder alloy and neutral binders.

KEY NO. 643

One-Part Epoxy for Spray Coating

A one-part epoxy coating powder can be applied to metal, glass and ceramic parts with conventional spray equipment.

The resin, called Scotchcast No. XR-5026, was introduced last summer by Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. as an aerated bed coating (M/DE, Aug '60, p 186).

Parts especially suited to epoxy spray coating are transformer cans and covers, computer racks, phone equipment mounting racks, switch

Titan® RC Hex

T.M.

Titan's new *RC Hex* is free-cutting brass hexagon rod with radius corners.

It offers exciting new advantages when used on screw machines. It is best for making bolts, nuts, hydraulic and automotive fittings, and other parts where the hex serves as a wrenching shape. Here's why:

Superior Points of RC Hex Brass Rod

- Weight-per-foot saving averages ½% over conventional sharp-cornered hex rod. Costs are less.
- Screw machines can take larger rod because of reduced dimension across Titan *RC Hex* rod corners.
- Screw machine operations are quieter and safer because sharp hex corners are rounded.
- Stock tube liners last longer. Machine downtime is reduced because of "rounded" hex bars. "Corner" damage is less. Higher speeds can be used.
- Parts made of Titan *RC Hex* take superior plating because of reduced buildup on corners. Finishing costs less.
- *RC Hex* facilitates assembly of finished parts.
- "Rounded" machined hex pieces don't nick or burr during handling and shipping.
- Finished products made from Titan *RC Hex* have improved "rounded" quality look . . . added to the natural beauty and strength of being brass.

Titan produces *RC Hex* rods in many sizes. Most are from ½" to 2½" across flats. "Special" die sizes are standard at Titan. Let us know your needs.

Consult Mill for *RC Hex* in alloys in addition to Free-Cutting Brass.

Order Titan *RC Hex* from your nearest Titan Man. Rapid shipments are made to you direct from four Titan brass rod mill depots: Bellefonte, Pa.; Seymour, Conn.; Indianapolis, Ind.; Newark, Calif.

Established 1915

Write for RC Hex die size list and catalog data

Chrome-plated brass parts machined from Titan RC Hex. Reduced buildup on corners gives superior plating results.

TITAN® METAL MANUFACTURING COMPANY

DIVISION OF CERRO CORPORATION

Bellefonte, Pa. • Newark, Calif. • Offices & Agencies in Principal Cities

RODS • FORGINGS • DIE CASTINGS • WELDING RODS • WIRE

For more information, turn to Reader Service card, circle No. 452

Machining Bond on Castings

Here's the MBC plan: if you uncover a flaw while working on one of our castings, we pay your machining cost. This is in addition to replacing the casting without charge.

Our customers like the Machining Bond on Castings. It is one more assurance that it pays to buy high quality castings in the first place. Please write for our booklet on the Resources and Capabilities of:

Morris Bean & Company
Yellow Springs, Ohio

aluminum and ductile iron castings

BEAN

For more information, circle No. 399

What's new IN MATERIALS

covers and other parts requiring a protective and insulating coating on only one side or over a particular area.

Parts to be coated are preheated to 350 to 450 F, depending on the heat capacity of the part and the desired thickness of the coating. When sprayed on a hot object, particles of the resin adhere, melt and flow to form a uniform, smooth coating. Overspray or unused resin can be reclaimed by using a dust collector and spray booth system. Coatings 5 to 30 mils thick are possible.

According to 3M, most coated parts will have sufficient residual heat to cure the resin completely. However, if parts are small or have a large surface-to-mass ratio, they will lose heat quickly and require brief postcuring. Recommended curing times and temperatures range from 30 sec at 450 F to 5 min at 300 F. KEY NO. 644

***Spray coating** a switch cover with one-part epoxy resin.*

Four New Powders Include Carbides, Iron

Four new micropowders have been added to a line of metal powders introduced last fall (M/DE, Sept '60, p 10) by Linde Co., Crystal Products Dept., 4120 Kennedy Ave., East Chicago, Ind.

The new powders are: 1) commercially pure ingot iron, 2) zirconium with 2% tin, 3) columbium carbide, and 4) titanium carbide. Although not in stock, some platinum and

Aluminum cans for electronic applications are cast accurate, smooth and pressure tight by the unusual foundry methods of Morris Bean & Company, Yellow Springs 1, Ohio.

BEAN aluminum ductile iron foundries

For more information, circle No. 398

Original sculpture created for 3M Co. by Guy Palazzola

THRIFT

. . . Save three ways fabricating with 3M Adhesives!

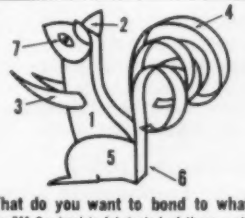
When a switch from brazing to adhesive bonding saves a timer manufacturer $56.37 per thousand . . . when adhesives replace rivets and cut assembly costs 25% for a maker of metal containers . . . when a new structural adhesive cuts pump assembly rejections to nearly zero . . . can you afford *not* to look into the cost revolution being worked by modern 3M Adhesives?

Save time, money, materials! 3M Adhesives eliminate hole-making, countersinking, heat-treating. They bond without impairing integrity of structural members. No nuts, bolts, rivets, staples, welding, brazing. Metal thickness, joint size are reduced. One operation bonds *and* seals. Quality bonuses: bond strength exceeding materials bonded, smoother contours, improved fatigue resistance.

You can bond any material to itself or another, with 3M Adhesives. Item: tool manufacturer stopped costly machining of motor end plates from solid bronze, by adhering powdered iron discs to aluminum castings. Results: lower machining costs, increased strength and portability.

Why not? Let 3M Adhesives help *you* save on production! For a realistic analysis of the cost-cutting possibilities inherent in your operation, call your nearest 3M Field Engineer or write: AC&S Division, 3M Company, Dept. SBHH-51, St. Paul 6, Minn.

"SCOTCH-WELD" is a Reg. T.M. of 3M Co. ©3M Co., 1961



What do you want to bond to what?

The 3M Squirrel is fabricated of these materials and bonded with 3M Adhesives, including "SCOTCH-WELD"® Brand Structural Adhesives:

1. Wood 2. Plastic 3. Aluminum 4. Stainless Steel 5. Copper 6. Brass 7. Glass

ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

For more information, turn to Reader Service card, circle No. 520

THESE MASSIVE NEW NYLON SHAPES CAN SAVE YOU MONEY!

Nylon has been proven in service as an outstanding bearing material because of built-in lubrication, ability to withstand abrasive and corrosive environments, and mechanical strength. And MC* nylon, newest of the nylon family, is more adaptable than any and most economical of all. Tubular bars, for example, cost less than other nylon formulations . . . even less than continuous cast bronze. Plate and rod sell at prices under competitive nylons.

POLYPENCO MC nylon has premium properties similar to nylon 101 with outstanding wear life, strength and resistance to deformation under load. Typical applications: rollers, bearings, bushings, gears, cams, forming devices, wear plates, tooling and general structural wear parts.

AVAILABILITIES

TUBULAR BAR: 2"-15" O.D.
SOLID ROD: 3"-24" O.D.
LARGE PLATE: ¼"-6" Thick

SPECIAL SIZES AND SHAPES ON REQUEST

Visit Booth 1105-7 Design Engineering Show

*Trademark of The Polymer Corporation

IN BUSHINGS

Non-scarring work holder bushings for disc grinding roller bearings.

IN BACK-UP ROLLS

5" I.D. x 7" O.D. x 13" long back-up rolls for die cutting outline and patterns of paper place mats and lace doilies save $2000 per machine in cost of rolls alone replacing Kraft paper rolls.

IN DRIVE ROLLERS

Support rollers for end grinding roller bearings.

THE POLYMER CORPORATION OF PENNSYLVANIA
Reading, Pennsylvania
Engineered Industrial Plastics
EXPORT: Polypenco, Inc., Reading, Pa.

POLYPENCO®

STOCK SHAPES • MOLDING RESINS • SINTERED PARTS • WHIRLCLAD® COATINGS

For more information, turn to Reader Service card, circle No. 494

What's new IN MATERIALS

99.9999% pure aluminum micropowders have also been processed.

The iron and zirconium are supplied as spherical powders 20 to 150 u in dia. The columbium carbide and titanium carbide powders are supplied as 1-oz research samples: the carbide powders are not spherical.

According to Linde, the metal powders are finding use in such applications as: impregnated cathodes in high power electronic tubes; sintered nuclear fuel elements; fuel cell electrodes and filters; catalysts in solid fuel propellants; and gas chromatography absorption base materials.

The micropowders are made by a new process in which 1/16-in. dia wire is used as the starting material. The wire is processed in an inert atmosphere to maintain high purity in the finished powder.

KEY NO. 645

Graphite Lubricant

Mexacote is the name of a quick drying, nontoxic graphite lubricant developed by United States Graphite Co., Div. of Wickes Corp., Saginaw, Mich. When thinned with turpentine, naphtha or oleum spirits, the lubricant is easily applied by brush, swab or spatula. After drying, a tenacious, durable coating with high lubricating action remains on the surface.

The lubricant was formulated especially for use on railroad equipment, but can also be used on all types of heavy industrial equipment.

KEY NO. 646

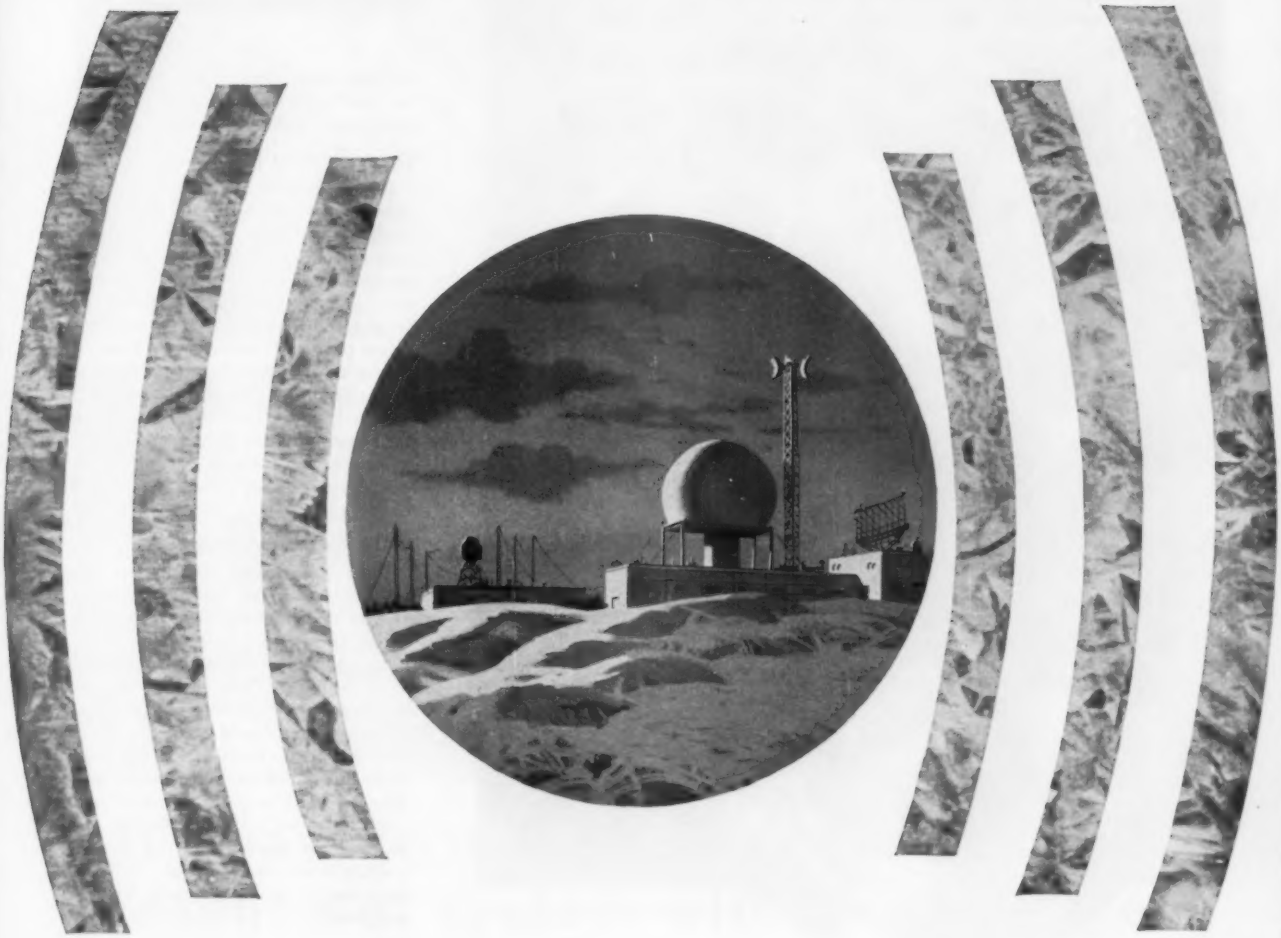
Steel Tubing Sold in Wide Size Range

Iron and steel tubes with o.d.'s ranging in innumerable variations from 2.25 to 50 in. and wall thicknesses from 0.250 to 8.0 in. are being turned out by a new centrifugal casting process at American Cast Iron Pipe Co., P. O. Box 2603, Birmingham 2, Ala.

The tubes are produced in carbon steel, low alloy steel, heat and corrosion resistant stainless steels, and both plain and alloy cast irons.

Applications for the tubing include

U.S. Air Force DEW-Line buildings fend off corrosion . . .



GUARDED BY GALVANIZED STEEL

Galvanized steel sheets—over 300 tons—will fill a vital need in the construction of unique air terminal/storage buildings for our Air Force's DEW (Distant Early Warning) Line.

The need? Maximum strength plus a defense against the DEW Line's dew point. Based north of the Arctic Circle, these buildings and their interior warmth will abut against bitter outside cold to create a temperature differential up to 130°—and a condensation-corrosion threat as extreme as the −60° surroundings. To eliminate the threat, each building will consist of: insulated galvanized steel floor construction, galvanized steel for outer skin of sidewalls, galvanized steel for inside (vapor barrier) face of sidewalls.

WEIRKOTE® IN PARTICULAR! To the inherent strength, economy and versatility of steel, Weirkote adds enduring zinc protection via the modern continuous process. As a result, Weirkote galvanized steel can be worked to the very limits of the steel base without chipping or peeling. And it assures you of long-lasting protection against corrosion. It is manufactured by two National Steel divisions, Weirton Steel and Midwest Steel. Write Weirton Steel Company, Weirton, West Virginia, for further details.

MIDWEST STEEL
Portage, Indiana

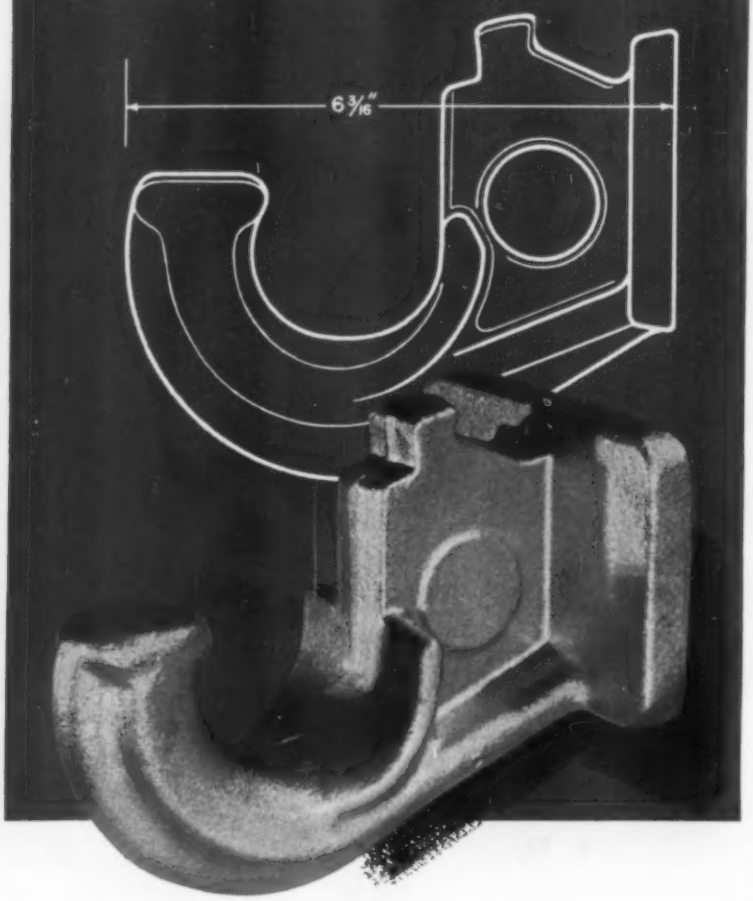
WEIRTON STEEL
Weirton, West Virginia

divisions of
NATIONAL STEEL CORPORATION

For more information, turn to Reader Service card, circle No. 340

PROBLEM:

Excessive draft from normal forging design resulted in high scrap and low die life.



SOLUTION:

AmForge recommended their "no draft" technique. The savings in scrap plus increased die life made the forging design both practical and economical.

Because the head was flat, without draft, the customer was not only given a reasonably priced forging, but was saved machining costs. A further bonus was better strength of the head due to improved grain flow.

If you have a similar problem, consult AmForge. Write for our new brochure and the name of your nearby AmForge sales engineer.

Remember: *your problems . . . our challenge!*

AM FORGE

a division of American Brake Shoe Company, 1220 West 119th Street, Chicago 43, Illinois. Two plants in Chicago, one in Azusa, California

WHEN IT'S A VITAL PART, DESIGN IT TO BE FORGED

For more information, turn to Reader Service card, circle No. 331

hydraulic cylinders, piston rods, textile and paper rolls, high pressure piping and unfired pressure vessels.

Ceramic mold is key

Key to the new centrifugal casting process is a ceramic mold that produces denser and sounder castings with assured concentricity. Conventional methods use either metal molds with a sprayed refractory facing or sand molds rammed around a cylindrical pattern inside a metal flask.

The new process, called Ceram-Spun, is said to permit spinning speeds 100 to 150 times gravity at the inside surface of the mold, compared to conventional centrifugal casting speeds of 50 to 100 times gravity.

Mold made centrifugally

The ceramic mold is produced centrifugally in much the same manner as the tubes themselves. A ceramic slurry is poured into a rapidly spinning metal flask, and centrifugal force separates water from the ceramic particles, forcing the particles to the inside surface of the mold. Water is then drained from the mold. Subsequent baking of the mold produces a hard ceramic lining of uniform diameter and high density. By varying the thickness of the ceramic mold, a wide range of outside diameters can be made in a metal flask of a given size.

Tubes are poured, spun

The casting operation is carried out by pouring molten metal from a hydraulically tiltable open ladle

***Steel tube** shown here was made by a new casting technique.*

An example of Avisco Rayons in Industry

It's easy to make non-wovens on your present wet system with Avisco® rayons

Avisco rayon fibers are ideal for making non-wovens on your existing wet system because fiber lengths, diameters and physical properties can be precisely controlled. You get all the economy of high-speed wet system operation plus the tremendous versatility of rayon.

Non-wovens of Avisco rayon can be made lustrous or dull, strong, flexible, drapable. Consider these fibers for napkins, table cloths, wiping cloths, filters, hospital sheets and pillow cases, disposable garments of all types, draperies and other applications both industrial and domestic.

Write for information on rayon in non-wovens, produced on the wet system. Send in the Quick Reply Coupon at right.

QUICK REPLY COUPON 8-4

Industrial Merchandising Division
American Viscose Corporation
350 Fifth Avenue, New York 1, N.Y.

Please contact me about Avisco Rayons for use in the following application:_____

Name_____

Company_____

Address_____

City_____ Zone____ State____

AVISCO RAYON

AMERICAN VISCOSE CORPORATION, 350 Fifth Avenue, New York 1, N. Y.

For more information, turn to Reader Service card, circle No. 377

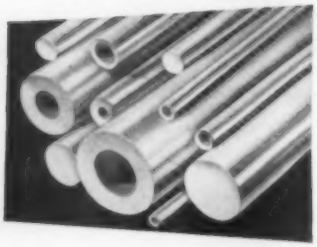
TEFLON*

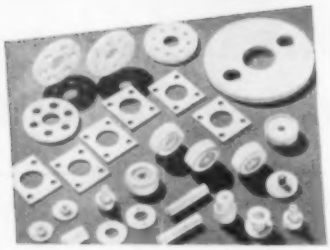
SHEET....ROD....

TUBING....MOLDED OR MACHINED PARTS?

YOU CAN GET JUST WHAT YOU WANT

from JOHN CRANE





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through a pouring spout orifice into the spinning mold. Pouring temperatures 150 F above the liquidus temperature are satisfactory for most steels. Pouring rates vary with the size and weight of a tube being cast. The operation must be fast enough to cover the mold wall without lapping, yet slow enough so the metal will be picked up by the spinning mold.

Spinning is continued until all the metal has solidified. Then the mold and casting are removed from the casting machine and stripped with a hydraulic ram and tube puller. The ceramic mold material is washed from the flask by high pressure water and used over again to produce new molds. **KEY NO. 647**

Breathable Vinyl

What is described as the "most breathable" fully coated vinyl upholstery material now on the market has been introduced by Knoll Associates, Inc., 575 Madison Ave., New York 22. It is called Brigadoon.

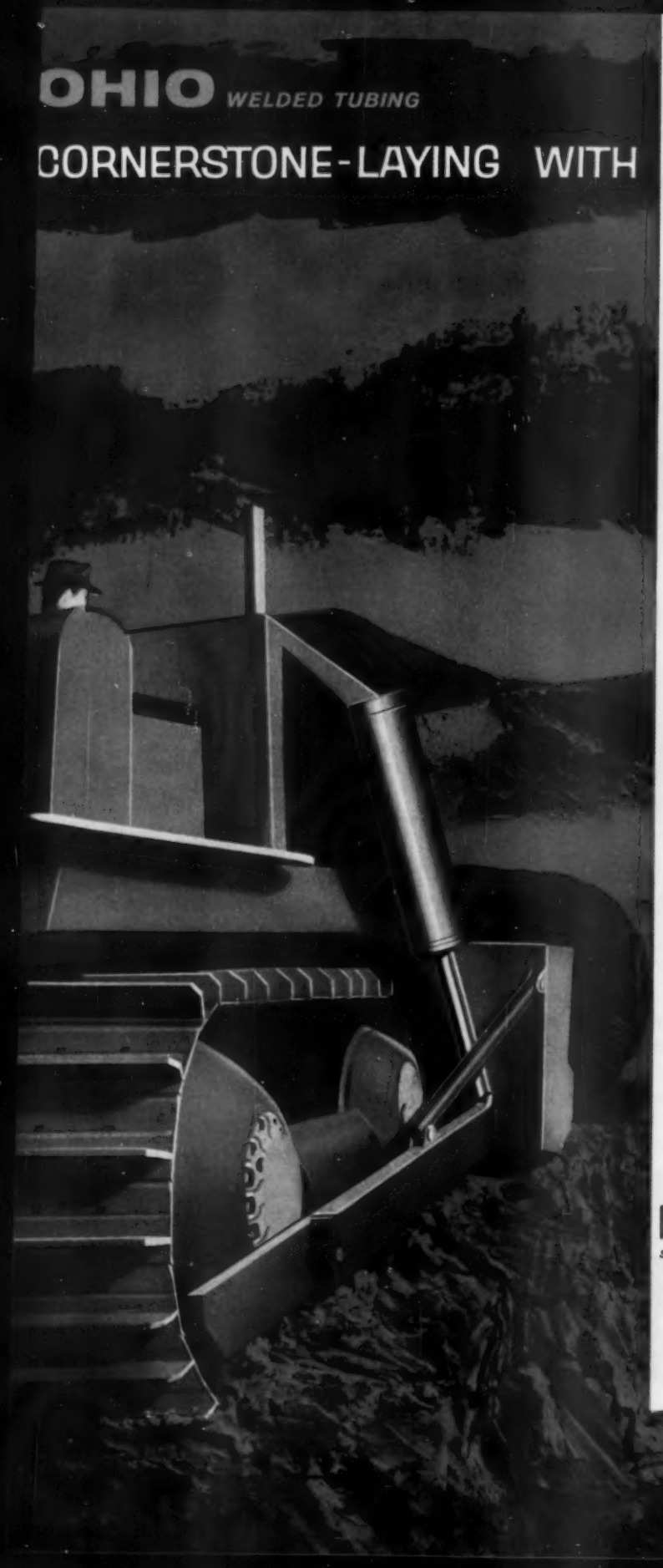
The producer says greater breathability is attained through a new perforation process (not disclosed) that permits air to circulate through thousands of invisible pores: air circulating through the pores dissipates heat and vapor, resulting in a cooler, more comfortable material. An elastic backing is said to assure smoother application and improved durability. **KEY NO. 648**

New Thermoelectrics Useful up to 2000 F

A new group of high temperature thermoelectric materials is said to permit the direct conversion of heat into electricity at temperatures considerably above the melting point of copper.

The new materials, developed by scientists of Westinghouse Electric Corp., Box 2278, Pittsburgh 30, are varieties of two compounds: samarium sulfide and cerium sulfide. They are said to have excellent high temperature stability and good thermo-

For more information, circle No. 394 ➤



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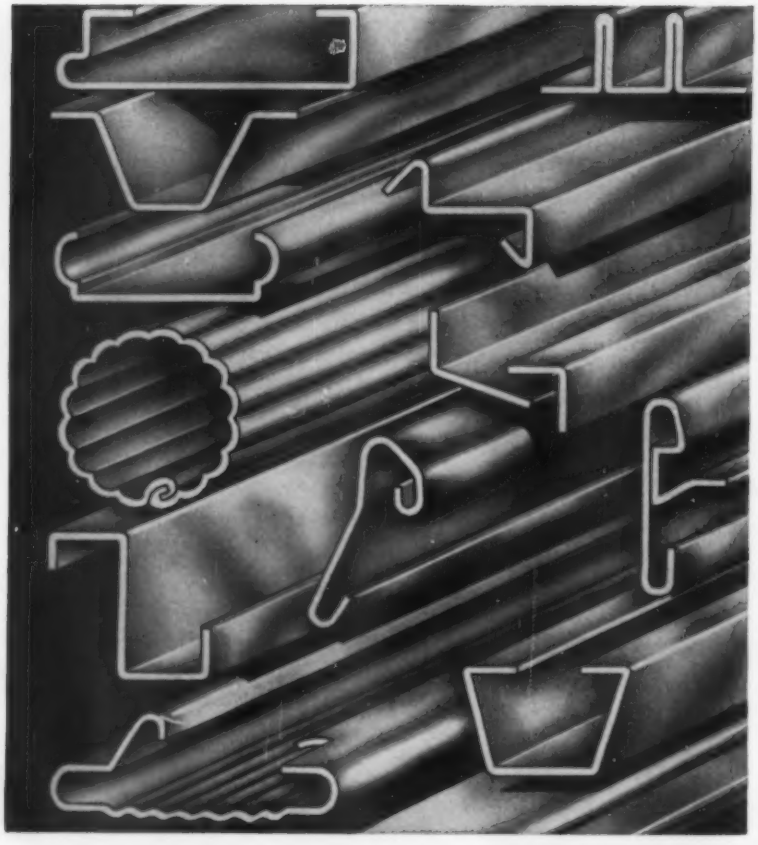

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For more information, turn to Reader Service card, circle No. 371

electric efficiencies at temperatures as high as 2000 F. The new materials are still under development.

Potential applications

The new thermoelectric materials are expected to find application in future thermoelectric power generators. To improve the overall efficiency of such power generators, several different types of thermoelectric materials are used in series or cascade. Each operates in the rather narrow temperature range at which it functions best, and each passes its waste heat along to the next lower temperature material.

Though not yet as efficient as lower temperature thermoelectric materials, the new compounds can be used as the top, or hottest, material in such a series. Thus they will permit the entire generator to operate at higher temperatures and raise its overall efficiency.

Metals combined with sulfur

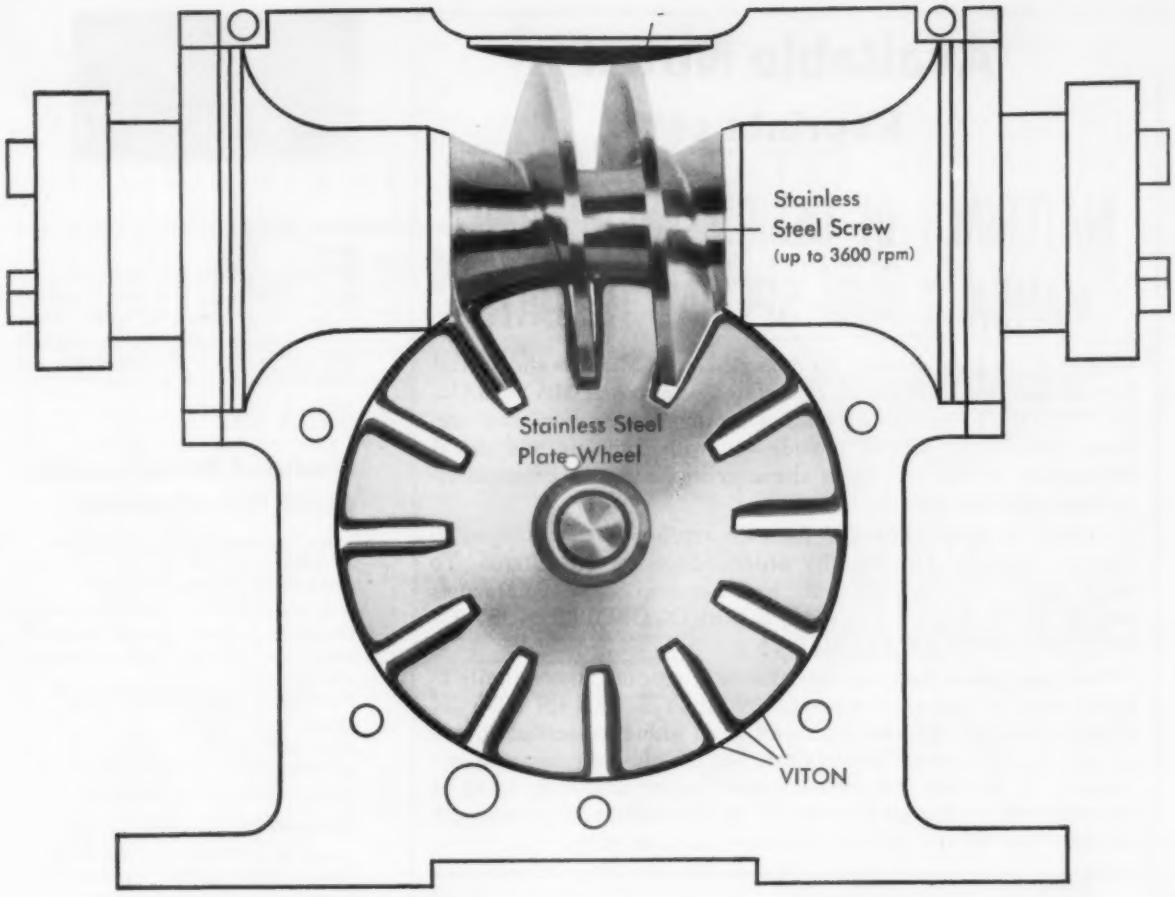
The two rare earth sulfides are prepared by directly combining the pure metal with sulfur. In the case of samarium sulfide, the samarium and sulfur are heated to high temperatures in a protective atmosphere. The rate of temperature rise, final temperatures, and length of reaction time are carefully controlled. Following the chemical reaction between the samarium and the sulfur, the resulting sulfide is crushed, compacted into cylindrical-shaped pellets, and sintered in a vacuum induction furnace.

One-Coat Organosols

A new series of vinyl-base organosol coatings is said to offer good protection to metal surfaces in a single layer. Also, the coatings require no primer as do conventional two-coat organosol coatings.

Called Sterilkote 360, the coatings are commercially available from Bradley & Vrooman Co., 2629 S. Dearborn St., Chicago 16.

A big advantage of the coatings is that they have better abrasion resistance than conventional two-coat organosol coatings. The producer says the coatings also have good resistance to humidity, water, salt



Durable VITON® helps solve corrosion, heat problems in design of new pulseless pump

A new twist on the 2000-year-old Archimedean screw principle has resulted in this unique positive-displacement pump, designed to handle highly viscous liquids and slurries containing abrasive and crystalline particles, without damage to crystals.

The key to the efficiency of this Goodyear* pump is the VITON-bonded plate wheel (see diagram). The slots are edged with durable VITON, which not only prevents galling, but exerts a squeegee wiping action that keeps "problem" liquids moving at full flow, without foaming or agitation.

Du Pont VITON was chosen for this application because of its exceptional resistance to corrosive chemicals and oil at high temperatures. No ordinary elastomer—natural or synthetic—could stand up to the corrosive attack while maintaining a positive seal at rotor speeds up to 3600 rpm.

Do you have a design problem that might be solved by VITON's unique combination of properties? To receive more detailed information, just mail the coupon below.

**A product of Goodyear Pumps, Inc., New York, N. Y.*

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spray, peeling, chipping, flaking and marring.

They are expected to be used on metal shelving, cabinets, display racks, metal furniture, office equipment, and interior panels of cars and buses. KEY NO. 649

Modified Stainless Has Good Machinability

An improved free-machining grade of stainless steel is said to have better machinability, better corrosion resistance and better resistance to splitting than type 303 stainless steel, the standard free-machining stainless steel grade.

Called Uniloy 303MA, the new grade is available from Universal-Cyclops Steel Corp., Bridgeville, Pa. It is supplied as bars, forging billets, plates, sheets, strip and wire.

Composition is key

The new grade is produced by reducing the sulfur content from 0.25% to 0.13% and adding 0.70% aluminum to the type 303 stainless steel analysis. According to the producer, the following five advantages are a direct result of the composition changes:

1. Output of machined parts is increased. In-plant testing indicates that Unuiloy 303MA can be machined up to 50% faster than type 303.
2. Tool life is increased.
3. Surface finish is improved. Uniloy 303MA can be electropolished to a very high luster similar to the finish obtained on types 302 and 304 stainless steels.
4. Corrosion resistance of Uniloy 303MA is 25 times greater than that

PROPERTIES OF TWO STEELS COMPARED*

Type→	303	303MA
Ten Str, 1000 psi	95-100	95-100
Yld Str (0.2% offset), 1000 psi	65-70	70-75
Elong (in 2 in.), %	45-50	40-45
Red. of Area, %	60-65	60-65
Brinell Hardness	207-212	207-212
Impact Str (Izod), ft-lb	80-85	80-85

*Tests performed on specimens taken from cold drawn bar stock.

progress through creative research in **ADHESIVES** *COATINGS . . . TREATMENTS . . .*

DESIGNER'S GUIDE TO CHEMLOK® ADHESIVES

Chemlok 220/203 . . . versatile adhesive system for bonding uncured elastomers to rigid substrates.

System bonds natural rubber, SBR, butyl, neoprene and nitrile —during vulcanization—to all metals, many plastics. Uniform high-strength bonds reduce rejects. Wide manufacturing tolerances cut costs. One coat of 220 outperforms most two-coat systems; 220 over 203 gives unmatched environmental resistance. Economical, high-quality bonding has made these the most widely used rubber-to-metal adhesives. **Request Bulletin No. 2012.**

Chemlok 301 . . . general-purpose structural epoxy adhesive.

This adhesive seals and fastens in one operation. It joins any combination of metal, glass, wood, fabric, ceramic, plastic, rubber and foam sponge. Removes potential leakage areas and points of stress concentration associated with mechanical fastening holes. High-strength bonds erase welding or soldering cost; permit use of lighter, cheaper materials. Chemlok 301 cures at room temperature with contact pressure, offers handling ease plus exceptional resistance to oil, chemicals, moisture and weathering. **Request Bulletin No. 3501.**

Chemlok 607 . . . high-strength, high-temperature adhesive for speciality elastomers.

Adhesive bonds uncured silicone, Hypalon, Viton A, Fluorel and other speciality elastomers to metals, glass, fabrics, or plastics. Exceptional bond strength at temperatures to 500°F. improves product versatility. One-coat application saves time, equipment and expense. Chemlok 607 provides environmental resistance equivalent to the stock, unique strength/temperature ratios. **Request Bulletin No. 6005A.**

Chemlok EX-B150-1 . . . speciality adhesive for elastomer-to-elastomer bonding during vulcanization.

EX-B150-1 forms durable, high-strength bonds between butyl, neoprene, natural, SBR and nitrile stocks. Bond flexibility permits prolonged exposure to heat and flexure without loss in dynamic properties or strength. EX-B150-1 aids in manufacture of rubber products where two or more elastomers are bonded to form a superior composite part. **Request Bulletin No. 5009.**

Chemlok EX-B579-1 . . . RTV silicone rubber adhesive.

One-part, one-coat speciality adhesive bonds room-temperature-vulcanizing silicone rubber to metals, ceramics, glass, plastics and cured epoxy resins. Bond is formed during cure. EX-B579-1 offers processing ease with all commercially available RTV silicone rubbers, produces rubber-tearing bonds with excellent environmental resistance to broad temperature conditions. **Request Bulletin No. 6006A.**

For better bonding at lower cost, investigate Chemlok Adhesives.
Write for complete technical details and evaluation samples.

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What's new IN MATERIALS

COMPOSITION OF TWO STEELS COMPARED (%)

Type →	303	303MA
Carbon	0.10	0.10
Manganese	1.50	1.50
Silicon	0.50	0.50
Sulfur	0.25	0.13
Chromium	18.00	18.00
Nickel	9.00	9.25
Molybdenum	0.50	0.50
Aluminum	—	0.70

of type 303 and approaches that of type 304 stainless steel.

5. Uniloy 303MA can be successfully roll threaded. The harmful effects of inclusions in regular 303 stainless steel prevent the forming of threads by rolling.

The improved stainless steel can be arc, flash and percussion stud welded, as well as brazed.

KEY NO. 650

Two New Laminates Are Fire Retardant

Formica Corp., 4614 Spring Grove Ave., Cincinnati 32, Ohio, has expanded its line of fire retardant industrial laminates to nine grades with the introduction of two new laminates.

1. Glass-epoxy laminate

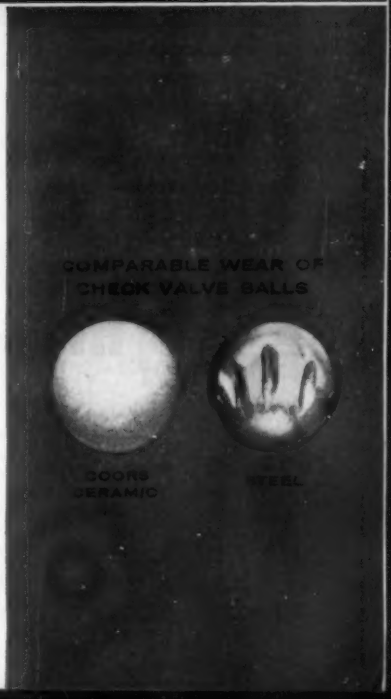
FF-93FR is a glass-epoxy laminate that is said to combine rapid self-extinguishing properties with excellent electrical and machining properties. It was developed to minimize the hazard of fires caused by high voltages in computer circuitry applications. At 300 F, 1/16-in. thick FF-93FR extinguishes after 3 sec in NEMA's modification of the ASTM D635 ignition test. The grade is available in all standard sheet sizes and thicknesses, with copper-clad or unclad finishes and close thickness tolerances. Strength, dimensional stability and electrical properties (see table) are said to remain high under adverse moisture conditions. KEY NO. 651

2. Paper-phenolic laminate

XXXP-100FR is a paper-base phenolic laminate designed for radio and TV chassis boards which require

COLD or HOT... Spherical Within 0.000020"

Tolerances up to 0.000020" can be obtained on Coors high alumina spherically ground balls. Tolerances remain constant at cryogenic, room or elevated temperatures, because the material is dimensionally stable over a wide temperature range. Applications for Coors spherically ground balls include bearings, gauges and check valves. Coors high alumina ceramics are hard (Rockwell 45N 75-81) and extremely wear resistant—over 240,000 psi to over 350,000 psi compressive strength—completely homogeneous—chemically inert—non-magnetic—less than half the weight of steel, less than one-fourth the weight of tungsten carbide. Spherically ground balls, spherical within 0.0001", are kept in stock covering a wide range of sizes. Write for Data Sheet No. 5004. Regional Sales Managers: WEST COAST, *William S. Smith, Jr., EM 6-8129, Redwood City, Calif.;* MIDWEST, *John E. Marozeck, FR 2-7100, Chicago, Ill.;* CENTRAL, *Donald Dobbins, GL 4-9638, Canton, Ohio;* EAST COAST, *John J. McManus, MA 7-3996, Manhasset, N. Y.;* NEW ENGLAND, *Warren G. McDonald, FR 4-0663, Schenectady, N. Y.;* SOUTHWEST, *Kenneth R. Lundy, DA 7-5716, Dallas, Texas;* OIL FIELD INDUSTRY, *William H. Ramsey, UN 4-6369, Houston, Texas.*



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Coors Porcelain Company

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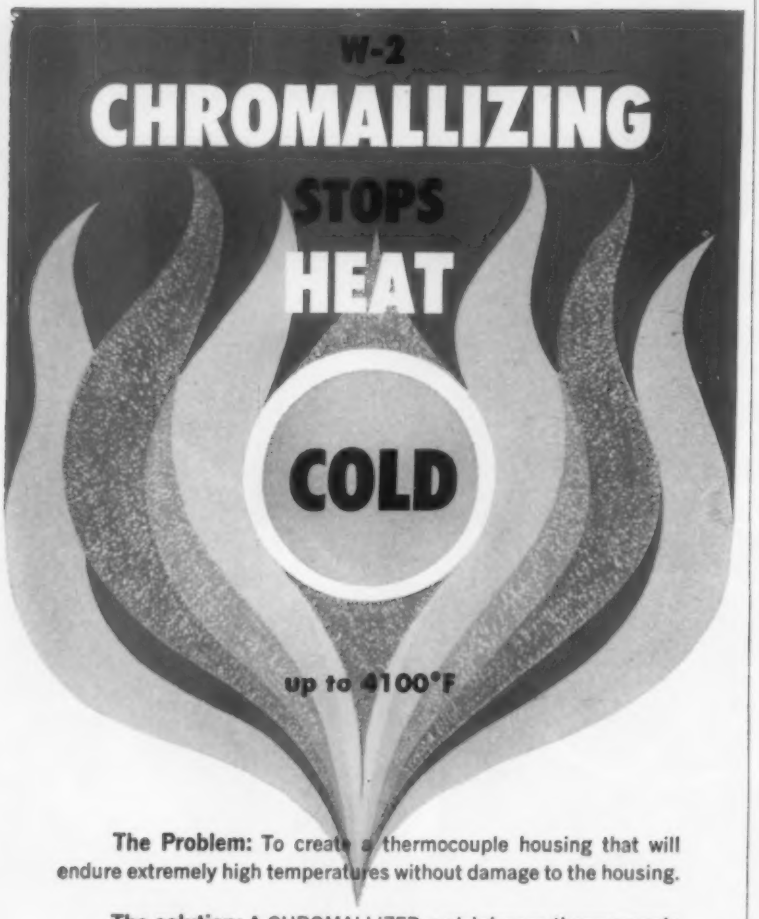
For more information, circle No. 483



The Problem: To create a thermocouple housing that will endure extremely high temperatures without damage to the housing.

The solution: A CHROMALLIZED molybdenum thermocouple housing. This housing withstands temperatures up to 4100°F. Other applications are structural parts for re-entry vehicles, high temperature testing grips, and ramjet engine components.

What is Chromallizing?
A proven process for diffusing chromium and other elements into the surface provides an alloy case which is integral with the base metal. It can't peel or flake. the chromium and other elements diffuse uniformly into recesses, pores, cracks and even blind holes.

CHROMALLIZING processes are also being used to protect superalloys for jet engine parts and to protect ordinary steel against wear, oxidation and corrosion.

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For more information, turn to Reader Service card, circle No. 354

What's new IN MATERIALS

PROPERTIES OF FF-93FR LAMINATE

PHYSICAL PROPERTIES	
Specific Gravity	1.90
Coef of Ther Exp, 10^{-5} per °F	
Lengthwise	0.72
Crosswise	0.89
Water Absorption (24 hr), %	
1/16 In. Thk	0.20
1/8 In. Thk	0.10
1/2 In. Thk	0.05
MECHANICAL PROPERTIES	
Tensile Strength, 1000 psi	
Lengthwise	45
Crosswise	30
Flexural Strength (flatwise), 1000 psi	
1/16 In. Thk	60
1/8 In. Thk	58
1/2 In. Thk	55
Compressive Strength (flatwise), 1000 psi	50
Izod Impact Strength (edgewise), ft-lb/in.	
1/8 In. Thk	10.0
1/2 In. Thk	11.0
ELECTRICAL PROPERTIES	
Dielectric Strength (perp, 1/16 in. thk), v/mil	
Short Time	800
Step by Step	600
Dielectric Constant (1/8 in. thk, 60 cps)	5.0
Dissipation Factor (1/8 in. thk, 60 cps)	0.005
Insulation Resistance, megohms	100,000

flame retardant and cold punching properties. Burn times of XXXP-100FR are under 5 sec in the NEMA modification of the ASTM D635 test. Cold punching and electrical properties are good. The laminate is supplied in thicknesses from 1/32 to 3/16 in. **KEY NO. 652**

Acetate Is Clear after Vacuum Forming

Clear, transparent sheets extruded from a new acetate formulation do not cloud or haze during vacuum forming operations. For example, deep draws on a four-tiered female test mold (see photo) showed no blushing, clouding or hazing when the new formulation was used. But the test mold usually caused conventional acetate sheet to cloud at the upper edge of the part.

The new formulation, called Tenite No. 081, is available from Eastman Chemical Products, Inc., 260 Madison Ave., New York 16.

The producer says sheet extruded

PLASTICS
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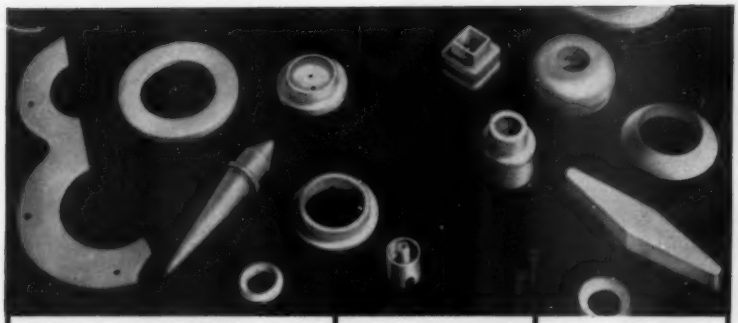
Engineering



PROPERTY	TEFLON (TFE)	TEFLON (FEP)
Specific Gravity	2.1-2.2	2.1-2.2
Tensile Strength, 73°F	2500-3000 psi(a)	2700-3100 psi
Elongation, 73°F	100-200%	250-330%
Compressive Stress at 1% Offset	1000 psi	700 psi
Impact Strength, Izod Notched, 77°F	3.0 ft. lb./in. of notch	Does not break
Heat Distortion Temp., 66 p.s.i.	270°F	162°F
Coefficient of Linear Thermal Expansion (Approximate Values per °F)	5.5×10^{-5} in./in./°F	5.23×10^{-5} in./in./°F
Dielectric Strength, Short Time, 1/16"	400-500 v/mil(b)	400-500 v/mil(b)
Surface Arc-Resistance	700 seconds(c)	165 seconds(d)
Volume Resistivity	$>10^{15}$ ohm-cm.	2×10^{15} ohm-cm.
Dielectric Constant (60 Cycles)	2.0	2.2
Service Temperature Range (Max.)	+500°F	+400°F
Service Temperature Range (Min.)	−395°F	−395°F
Water Absorption	0.0%	0.0%
Flammability	Nonflammable	Nonflammable

(a) Tensile strength in oriented film may be as high as 15,000 psi.
(b) Value is 1000-2000 v/mil in thicknesses of 5 to 12 mils.
(c) Does not track.
(d) Samples melted in arc after 15 seconds, but did not carbon track.

This table compares the properties of Teflon* TFE and FEP. The newer FEP can be injection molded. In designing, consult your Garlock plastics specialist for best application results.

In designing intricate parts, consider the benefits of Teflon as a material.

Teflon offers a unique combination of properties unmatched by other plastics. It possesses the lowest coefficient of friction, the best non-stick characteristics, the most complete chemical resistance and the widest useable temperature range available in any plastic. Teflon eliminates lubrication, corrosion, contamination, seizing; it reduces friction, wear, space required, weight. Teflon can be used in a thousand different ways—for packings, gaskets and seals . . . for connectors, insulators, and test points . . . for valves, bearings, couplings, and insulation.

In producing intricate Teflon parts, consider the benefits of Garlock as a supplier. From virgin powder to finished piece, Garlock closely controls each step in the process to assure that the final part performs to your expectations. Complete facilities are at your disposal for molding, extruding, and machining of Teflon. If your application calls for special properties, Garlock will compound Teflon with selected fillers to greatly extend its service range. If you need unusually large configurations, Garlock will fusion-weld Teflon . . . the weld will have the same thermal, chemical and electrical properties as the Teflon itself.

Parts made from Nylon, Delrin*, C.T.F.E., Lexan† are also available from Garlock. Let your local Garlock representative quote on your design, or ask his assistance on any design problems concerning materials and applications. Call him at the nearest of the 26 Garlock sales offices throughout the U.S. and Canada. Or, write for Catalog AD-177. Garlock Inc., Palmyra, N.Y.

GARLOCK

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

*DuPont Trademark
†General Electric Trademark

For more information, turn to Reader Service card, circle No. 384

THE 'HEART' OF THE MARKITE POTENTIOMETER

1. A potentiometer element—embodying resistance track and take-off track of conductive plastic co-molded to an insulator base. 2. An I-S cantilever dual spring (with precious metal wipers); maintains contact with conductive tracks even under 70g vibration at 5-2000 cps, 100g shock and 100g acceleration!

Instrument Specialties' cantilever springs provide high reliability in potentiometers, servomechanisms, electro-mechanical controls and instruments for aircraft, missiles and similar continuous-duty applications.

Employed in Markite conductive plastic precision potentiometers, I-S beryllium copper cantilever springs *maintain* their high spring forces . . . thereby complying with Markite's standards for infinite resolution and minimal contact noise over an operational life span of more than 50 million revolutions.

If you have a spring problem—Ask I-S engineers for a recommendation on your specific application; or request catalog containing complete data on I-S Beryllium Copper Compression Springs, Flat Springs, Contact Strips, Strip Springs, Contact Rings and Screw Machine Parts.

SEE OUR CATALOG IN SWEET'S

TWX:LTFS, N. J.-1023

"MICRO PROCESSED" I-S BERYLLIUM COPPER SPRINGS

INSTRUMENT SPECIALTIES COMPANY • INC.

224 Bergen Blvd., Little Falls, N. J.—Telephone: CLifford 6-3500

For more information, turn to Reader Service card, circle No. 331

from the formulation is well suited for use in blister, bubble and skin packaging applications where a high degree of sparkle and transparency is important.

The formulation can be extruded on conventional sheet extrusion equipment. **KEY NO. 653**

***Vacuum formed part** made of new acetate formulation shows no sign of hazing or clouding.*

Resistance Alloy Can Be Used up to 2000 F

A new iron-chromium-aluminum resistance alloy is intended primarily for use in small appliances and other devices requiring low cost, low growth heating elements that operate at temperatures up to 2000 F.

Designated No. 750, the alloy is available in a complete range of wire and ribbon sizes from Hoskins Mfg. Co., 4445 Lawton Ave., Detroit 8.

The new alloy is said to have greater ductility, uniformity and mechanical stability at high temperatures than similarly composed alloys.

The producer says that although the alloy's resistivity of 750 ohm/cmf at 68 F is somewhat lower than that of other iron-chromium-aluminum alloys, its increase in resistance from room temperature to operating temperature is much greater. According to Hoskins, this means that fewer cold ohms and fewer feet of No. 750 wire are required to produce the hot ohms necessary to obtain a given temperature. Conversely, the alloy's

WHY PAY FOR METAL WASTE?

Here is how to cut costs on your next tube order... by eliminating excessive metal waste and unnecessary machining time.

NOW FOR THE FIRST TIME you can order the exact size tube O.D.'s you need from 2.25" to 50" with wall thicknesses from .25" to 8". An exclusive "first" in centrifugally spun tubing — the ACIPCO CERAM-SPUN® process* makes this revolutionary development possible.

YOU BUY WHAT YOU NEED... NO MORE. Furthermore, the cost of unwanted crop ends can be eliminated and tubes can be cast to specified lengths from 4 feet to 20 feet. Longer lengths are made by welding.

OTHER ADVANTAGES? ACIPCO's complete "under one roof" operations — including heat treating, machining and welding — save you the delays and excessive costs that often result in buying from multiple supply sources.

Let us tell you more about ACIPCO CERAM-SPUN® ... contact us today. ACIPCO STEEL PRODUCTS, Division of American Cast Iron Pipe Company, Birmingham 2, Alabama.

*Patent applied for

ACIPCO CERAM-SPUN®
STEEL TUBING

For more information, circle No. 454

MEEHANITE MEANS BETTER CASTINGS®

Mixing screw for Aluminum Oxide Grain cast in type AQ Meehanite metal, replacing stainless steel. Outside diameter and shaft machined then air hardened to 44 Rockwell C. No distortion.

New AQ Meehanite®
Air Hardens....No Distortion

This new wear and abrasion resisting type of Meehanite® is a low cost metal of extremely high hardenability that offers many performance and cost advantages. It is recommended for critical castings of varying section size that require a Brinell hardness over 400 and which must retain accurate dimensions.

Such castings, made in type AQ Meehanite which has an "as cast" hardness up to 280, can be machined first, if necessary, and then safely air hardened without the risk of cracking or distortion associated with water or oil quenching. Final hardness — up to 500 Brinell; tensile strength — 66,000 psi.

AQ Meehanite® can easily be locally hardened for improved wear resistance of working faces and edges of such parts as dies, punches, cams, sheaves, etc. Another advantage is that the hardness at elevated temperatures is considerably better than most engineering materials. Also, AQ Meehanite, because of its manganese content, exhibits considerable work hardening during service.

For more information about AQ Meehanite®, send for your free copy of our 4-page folder, B-48. Write to Meehanite Metal Corporation, 714 North Avenue, New Rochelle, New York.

MEEHANITE METAL

MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES.

For more information, turn to Reader Service card, circle No. 333

increase in resistance when heated is appreciably less than that of similar alloys, a characteristic that enables it to maintain greater temperature stability throughout its useful life.

KEY NO. 654

One-Dip Cadmium Conversion Process

What is described as an inexpensive single-dip chromate conversion coating process for cadmium has been introduced by Hanson-Van Winkle-Munning Co., Church St., Matawan, N. J.

The process, called Chem-Rite C-55, is said to enhance the brightness of the cadmium deposit, producing a clear chromate surface. It is easy to operate and no leaching is necessary as with other cadmium bright dip treatments.

A big use will probably be as a protective coating for hardware and other cadmium-plated products that require long shelf life without discoloration and loss of brightness.

KEY NO. 655

Polypropylene Resins Are Heat Resistant

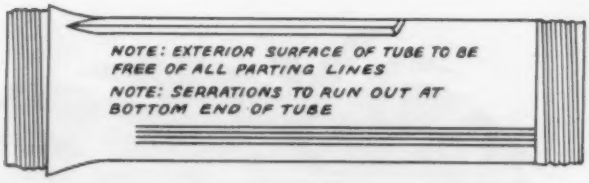
Four new polypropylene resins have been introduced recently. The resins withstand prolonged exposure to relatively high temperatures.

Three of the resins, called Poly-Pro, are available from Spencer Chemical Co., Dwight Bldg., Kansas City 5, Mo. The other resin, called Escon, is available from Enjay Chemical Co., Div. of Humble Oil & Refining Co., 15 W. 51st St., New York 19.

Poly-Pro 9 and Poly-Pro 12 are general purpose materials that have Federal Drug Administration clearance for use in contact with food. Spencer says that Poly-Pro 9 gives excellent clarity in thin-section parts such as hypodermic syringe barrels. Poly-Pro 12 is a high flow material designed for fast molding cycles.

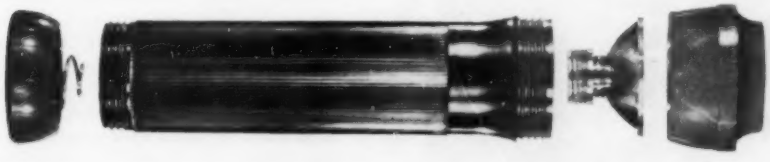
Poly-Pro 10 is a special heat-stabilized resin that is said to withstand

All-plastic case shows finely drawn functional detail— Tube, lens ring, and cap are all molded of BAKELITE Brand high-density polyethylene. The designer made good use of this material's functional properties. Fine details are reproduced with fidelity—serrations on the tube are precisely formed and provide a firm grip. Minimum finishing after molding helps keep mass production costs low. Tough and rigid with excellent chemical resistance, the flashlight will take hard usage. Its gloss adds sales appeal. On top of all these design advantages, the low price of this material makes it an even stronger value.



Molded-in threads, hidden parting line make this design unusual— Because of the high temperature resistance of BAKELITE Brand high-density polyethylene, these flashlight components always hold their shape. The molded ten-pitch threads don't soften, keeping the lens ring and cap firmly in place.

While the threaded sections at the bottom and top of the tube required a parting line, the designer specified that the main body of the tube have no parting line. The one-piece mold used for this feature costs more, but the appearance of the finished product makes it worthwhile. A slight taper in the tube permits easy removal from the mold. Since holes for the switch plate are molded in, there's no need for drilling or piercing.



HIGH-DENSITY POLYETHYLENE
...Idea-material for new designs

The Eveready "Shop Lite" gained several advantages when the designer chose this new polyethylene. Check the high points on this page . . .

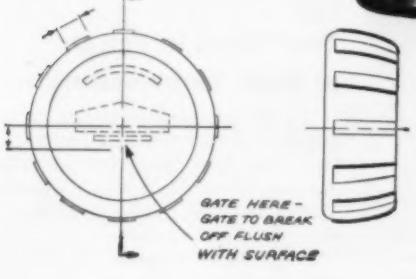
A new material often expands the designer's opportunities to try new ideas. This is especially true of high-density polyethylene, which offers properties that can reduce costs, extend performance, and improve appearance. Polyethylenes are only one group of BAKELITE Brand Plastics—the others are epoxies, phenolics, styrenes, and vinyls—that you can draw on. Molded, laminated, extruded, and in coatings, BAKELITE Brand plastics can be a source of genuine product improvement.

Check their properties in Sweet's Product Design File, Section 2a/ui.

This was an informal test—but it demonstrated the toughness and impact resistance of the BAKELITE Brand high-density polyethylene used in the EVEREADY "Shop Lite." It came through the bump, bounce, and batter undamaged.

Clean mold gating, color, feature high-density polyethylene – The designer called for a conventional gate on the flashlight cap mold; the tube and lens ring molds have a "diaphragm" gate used in fabricating tubular plastic designs. See how the finished part compares with his design. The cap and lens ring come in three glossy colors – red, yellow, and green—an attractive combination with the black tube.

Visit our booth at the Design Engineering Show, Cobo Hall, Detroit May 22-25.



UNION CARBIDE

BAKELITE, EVEREADY, and UNION CARBIDE are registered trade marks of Union Carbide Corporation.

Dept. JF-85E, Union Carbide Plastics Company
Division of Union Carbide Corporation
270 Park Avenue, New York 17, New York

Please send me information on the use of BAKELITE Brand plastics in design with particular emphasis on these properties _____.
The type of application being considered is _____

NAME _____

FIRM NAME _____

STREET _____

CITY _____ ZONE ____ STATE _____

For more information, turn to Reader Service card, circle No. 378

Are Small Precision Metal Parts Getting In Your Hair?

If you need precision in small metal parts you can get it from Torrington—plus exactly the right finish, temper and hardness required for your needs. Moreover, Torrington can produce such parts at high speed and a remarkably economical cost. We are the leading specialist in this field—with the specialized skills, engineering experience and facilities to save you money. If you have small parts to be manufactured in large quantities why not let Torrington solve your entire problem. Let us hear from you and your request will receive prompt action.

progress through precision **SPECIAL METAL PARTS**

THE TORRINGTON COMPANY Torrington, Conn.

For more information, turn to Reader Service card, circle No. 442

prolonged exposure to temperatures up to 250 F without discoloration or degradation. The new resin is recommended for home laundry and dishwasher parts, hospitalware, television backs and slide projectors.

KEY NO. 656

Escon 125 LTHA is Enjay's new molding grade polypropylene resin. It is especially recommended for applications in which molded parts are subjected to repetitive, long-term heat exposure such as backs for television sets, radio cabinets, under-the-hood automotive parts, lighting fixtures and appliance parts.

According to Enjay, test specimens molded of Escon 125 LTHA have withstood more than three months oxidative aging at 300 F without any signs of failure. KEY NO. 657

Decorative Hardboard for Interior Uses

A decorative hardboard panel has colored particles in a scatter mosaic design on a neutral, light blond background. The panel face is sealed to protect against stains and abrasion.

The hardboard, called Sandalite, is available from Forest Fiber Products Co., P. O. Box 68, Forest Grove, Ore. It is supplied in plain panels in thicknesses ranging from 1/8 to 1/4 in. Lengths range from 4 to 16 ft.

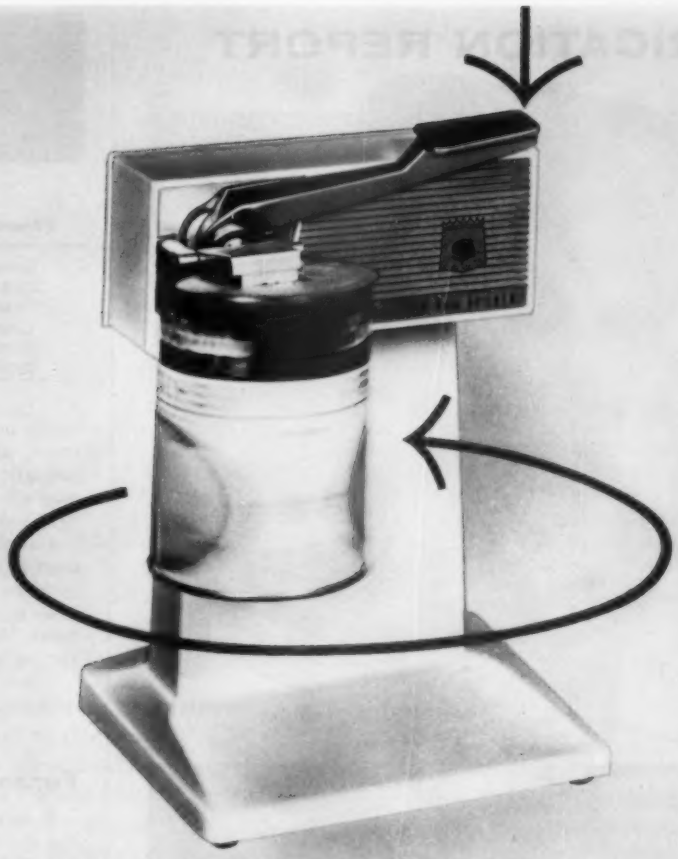
The hardboard can be fabricated with ordinary hand and power woodworking tools. It is expected to be used for counters, paneling, doors, novelty furniture, table tops, display fixtures and room dividers.

KEY NO. 658

Tool Steel Is Tough at High Temperatures

A new high speed tool steel called Braecut has been introduced by Braeburn Alloy Steel Corp., Braeburn, Pa. Because of its high cobalt content (12%), the steel retains its hardness at elevated temperatures.

When double tempered to a Rockwell hardness of C70, the tool steel



Silent nylon gears drive new Sunbeam electric can opener

Manufacturers are often able to gain more than cost savings through the use of custom-molded plastic components. A good example is this new Sunbeam electric can opener. To obtain quiet, maintenance-free operation, custom molded nylon gears were used instead of metal. For appearance, strength and ease of cleaning, Tyril®, a rigid thermoplastic, was used for the housing and base.

Chicago Molded sales engineers worked closely with Sunbeam designers in the selection of Nylatron® GS nylon for the gear train because of its sound-deadening, wear-resistant and self-lubricating qualities. Tyril was selected because of its resistance to acids, soaps, and food stains. Through the combined engineering skills of both Sunbeam Corporation and Chicago Molded Products, it was possible to design and produce more efficient, less costly components that resulted in a superior, better selling end-product.

Send for new brochure "Design and Purchase of Custom Molded Plastics."

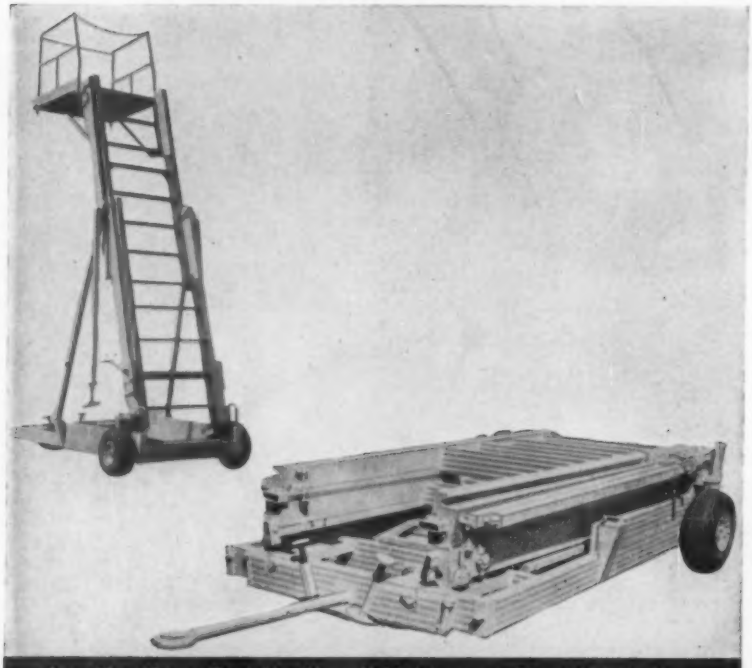
CMPC

CHICAGO MOLDED PRODUCTS CORPORATION
1020 F North Kolmar Avenue
Chicago 51, Illinois

For more information, turn to Reader Service card, circle No. 341

LUBRICATION REPORT

(TFE coating)



Application: *Portable Aircraft Maintenance Stand Lubrication.*

Problem: *To Minimize sliding friction at widely varying temperatures.*

Solution: *'EMRALON'® 310 (a tetrafluoroethylene pigmented, bonded film lubricant)—spray-applied and baked at 300°F. for one hour.*

RESULT: *ALL-WEATHER COATING GIVES TELESCOPING STAND NEEDED LOW-FRICTION SLIDING SURFACES*

This lightweight portable aircraft maintenance stand was developed for use by the U. S. military forces by South River Metal Products Co., Inc., of South River, N. J. Approximately 40 lineal feet of telescoping surfaces are contained in the stand which elevates to 13 feet for use, and compacts to a height of only 2 feet for transporting. Tests showed that the sliding magnesium sections were readily subject to galling and seizure. The dry-film coating obtained with Acheson's 'EMRALON' 310 provides the necessary lubrication through an ambient range from desert heat to Arctic sub-zero temperatures . . . and does not cake, evaporate or freeze.

Perhaps one of Acheson's series of TFE coatings can help solve your dry-film lubricating problem. Write for 'EMRALON' 310 or 'EMRALON' 320 (air dry) Product Data Sheets. Dept. ME 51

ACHESON—First name in solid lubricants for fifty-three years.

ACHESON *Colloids Company*

PORT HURON, MICHIGAN

A division of Acheson Industries, Inc.

Sales offices in principal cities.

Also Acheson Industries (Europe) Ltd. and affiliates, London, England

For more information, turn to Reader Service card, circle No. 359

What's new IN MATERIALS

COMPOSITION OF BRAECUT (%)

Carbon	1.15
Chromium	4.25
Vanadium	2.25
Tungsten	5.25
Molybdenum	6.25
Cobalt	12.00

can be used to machine high temperature alloys and the new high strength steels. The steel has been used effectively to machine an alloy hardened to Rockwell C50.

According to Braeburn, heat treatment follows normal procedures. For optimum hardness and toughness the steel is austenitized at 2225 F; extreme hardness requirements are met by austenitizing at 2250 F.

KEY NO. 659

Furane Coating

A corrosion resistant furane coating for interior and exterior applications has been introduced by Met-Con Laboratories, Box 7103, Houston 8, Tex.

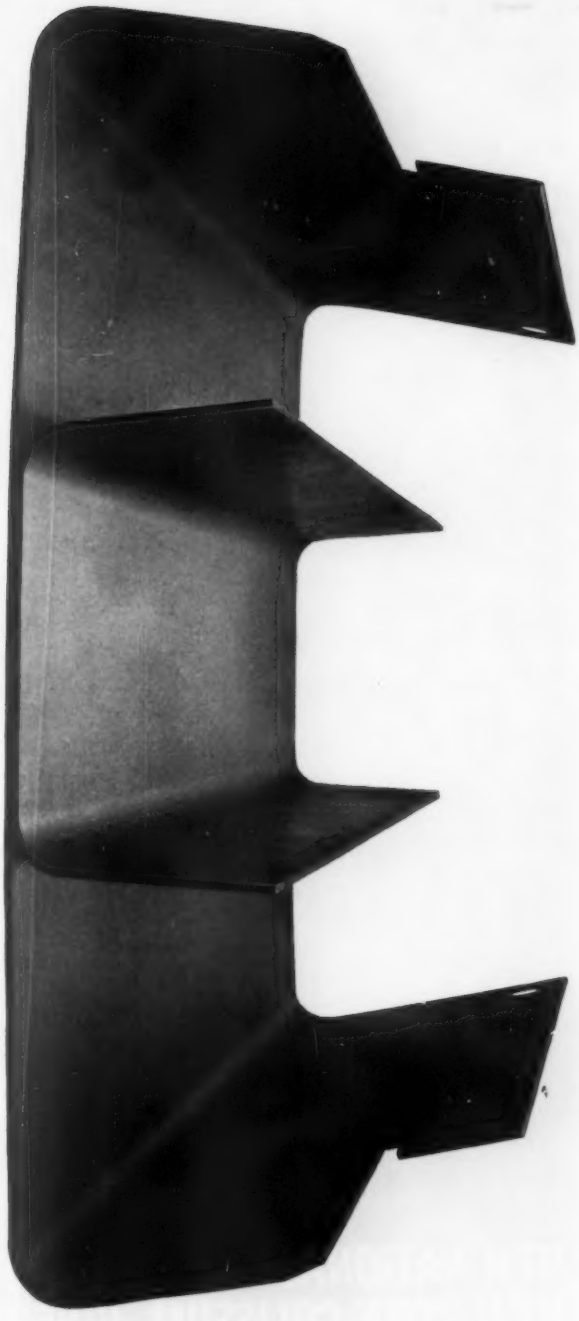
The coating, called Permaspray, is said to have excellent resistance to such materials as acetic acid, ammonia, gasoline, hydrochloric acid, salt water, barium chloride, fuel oil, tannic acid and kerosene. It is not affected by weather or ultraviolet light and withstands temperatures up to 200 F.

Recommended uses: chemical process equipment, bridges, oil and gas storage tanks, power distribution stations, metal buildings, railway equipment, ships and marine equipment. **KEY NO. 660**

Doped Silicon for Electronic Devices

Single-crystal silicon, doped to the specific requirements of electronic devices is now available from Dow Corning Corp., Midland, Mich. The material is supplied as rods in diameters up to 1 in. and lengths up to 14 in.

The producer says p-type single crystal material contains about 0.1 atom of minority impurity per billion



Practical approach to compactness is demonstrated by this flame retardant, interphase insulating barrier for magnetic air circuit breakers. When the equipment was designed, CDF utilized its extensive knowledge of adhesives and post-forming to provide the barriers from a flame retardant, paper base phenolic laminate.

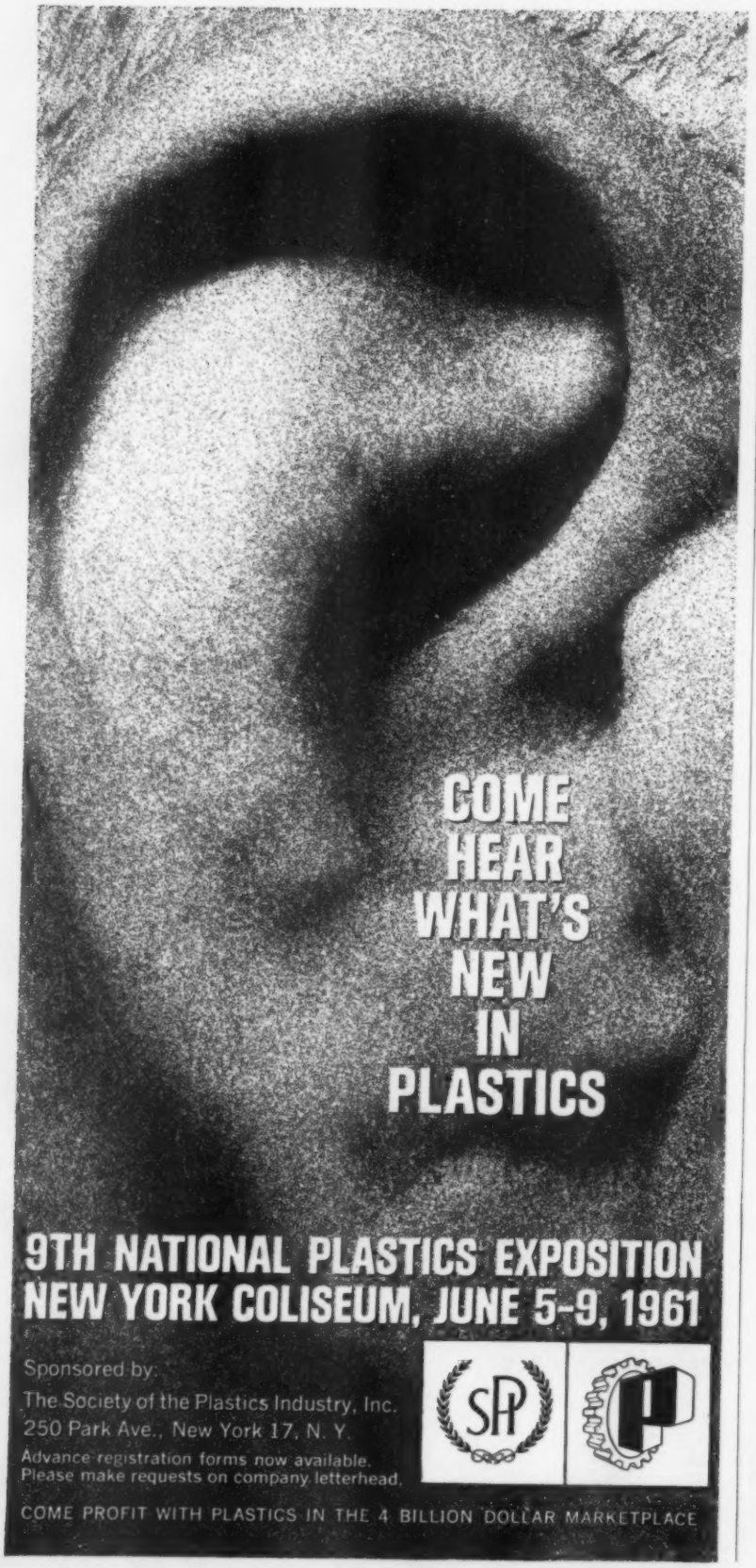
Result: two pieces bonded together to provide three channels in one unit, reducing size and cost, yet maintaining effective electrical insulating properties.

A few facts on the laminate:

Flame resistance: ASTM D-635
... self extinguishing
Water absorption, % 1.8
Flexural strength, psi 12,000
Specific gravity 1.38
Dielectric strength, parallel, kv ... 40

CDF® CONTINENTAL-DIAMOND FIBRE

CONTINENTAL-DIAMOND FIBRE CORPORATION, NEWARK, DELAWARE • A SUBSIDIARY OF THE Bakelite COMPANY



For more information, turn to Reader Service card, circle No. 486

What's new IN MATERIALS

Checking *doped single-crystal silicon rod for linear resistivity.*

atoms of silicon; n-type about 0.15. The low density of minority impurity is said to insure minimum variations in the characteristics of completed electronic devices. **KEY NO. 201**

Polybutadiene Rubber Resists Abrasion

A carboxy-modified polybutadiene rubber is said to have excellent abrasion and ozone resistance and excellent electrical properties.

Tests show the rubber does not become brittle at temperatures down to –85 F. It has moderate resistance to fuels, solvents and chemicals.

The rubber, called Hycar 1000X-145, is available from B. F. Goodrich Chemical Co., 3135 Euclid Ave., Cleveland 15, Ohio. It sells for 50¢ per lb in truckload lots.

Applications foreseen for the new material include electrical insulation, machine parts, hose coverings, fabric coatings, lineman's gloves and boots, shoe soles and heel lifts.

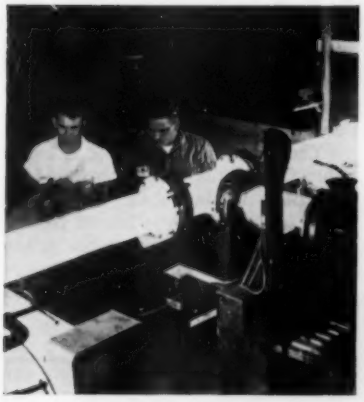
KEY NO. 202

High Melting Wax for Electrical Uses

A new synthetic wax with a melting point of 313 F is recommended for use as a coating and encapsulat-

THIS IS GLASS

A BULLETIN OF PRACTICAL NEW IDEAS FROM CORNING



HOW TO STUDY A BLIP

When you go to all the trouble of generating two opposed gas waves, each travelling eighty times the speed of sound, you like to get a permanent visual record of what happens when they meet.

A gas physics group at Boeing Scientific Research Laboratories is doing this with the help of a twelve-foot length of PYREX® glass pipe . . . believed to be the largest tube ever used in work of this sort.

At wave impact the tube blips light for a few microseconds, and a camera stops the action and spectra of the radiation for further study.

The data collected could show important results in effective ion- and plasma-propulsion systems. The tube is also expected to be useful in measuring gas temperatures up to several million degrees.

The tube is made from the same tough borosilicate glass as our pipe for chemical and food processing plants and our drainlines and heat exchangers.

If you would like to know more about it, so that you could put its strength and transparency to work on some task of yours, send the coupon.

WE NEVER MADE A TEST TUBE GREEN; WE NEVER HOPE TO MAKE ONE, BUT . . .

Should you want a test tube green or yellow or blue or a mirror-blank red, a piece of pipe cerise, or anything else that can be made from glass in any color known to man, we can make it.

That's no trick. Anyone can make colored glass.

But to make a glass the same color, right on the beam, every time . . . that, sir, is a trick, a trick we perform to perfection.

We helped set the color standards for railroad and airport and traffic signal lenses and then were able to duplicate and reduplicate the standard colors a million times.

This man is looking through one of many drawers of samples of colored glasses we have melted and can duplicate for you. Among these glasses you will find many that can take thermal shock or corrosive environments, glasses with high dielectric constants or low, glasses that are transparent, translucent, or practically opaque . . . in short, glasses that not only have carefully controlled color but are replete with the many other desirable properties you connect with Corning products.

From these glasses we can make you things that are big. Or small. One. Or a million. Intricate. Or simple.

That's our story on color in glass . . . capability.

All we need are your ideas. All you need to get started is our bulletin on colored filters to get an idea of the range we're speaking of. Send the coupon for a copy.

NEW WAY TO HOLD THINGS UP WHEN YOU GO DOWN TO THE SEA

Glass goes well with the briny. That's more than you can say for most materials.

It's also why we think glass may make the perfect flotation capsule.

We've already made an 8″ by 4″ capsule that withstands 17,500 psi. It has a density of 0.45 that of water. You can lower it to 3000 fathoms and retain a net upward force of about one pound.

You can put it into the saltiest sea and leave it for centuries, and it will never let you, or the objects you suspend, down. (Remember those wine bottles they found sleeping at the bottom of the Mediterranean some twenty centuries after the ship had sunk?)

With a capsule like this you should find it a simple, inexpensive matter to suspend instruments for the study of marine life, ocean currents, and underwater topography. You could suspend transoceanic communications equipment.

We welcome any interest you might have in these or even larger capsules. Please write.

CORNING MEANS RESEARCH IN GLASS

CORNING GLASS WORKS, 5005 Crystal St., Corning, N.Y.

Please send information on:

☐ PYREX glass pipe ☐ Colored filters ☐ Flotation capsules

Name..... Title.....

Company.....

Street.....

City..... Zone..... State.....

For more information, turn to Reader Service card, circle No. 451

It usually pays
to
TAKE A SECOND LOOK

. . . even at products which have long been considered "perfected".

The familiar crown cap, for example. Composition cork inserts have been used for nearly a century — more recently in combination with foil or coated paper. Now the advent of vinyl dispersions has brought about an exciting change in gasket design, and CHEM-O-SOL is playing an important part in it.

Dispensed into the crown shell as a liquid, CHEM-O-SOL takes shape under the light pressure of a metal die and fuses quickly with heat. Another version is uniformly distributed by centrifugal force and expands to a foam as it fuses. Less material does the same job, and it's applied in one operation instead of two. Sealing properties are excellent and delicate flavors are protected, too.

This is only one example. There are hundreds of other exciting possibilities for our CHEM-O-SOL coating, molding, and gasketing material. The CHEM-O-SOL brochure will help you to *take a second look* at your own products. Write Chemical Products Corporation, King Philip Road, East Providence, Rhode Island.

CP **CHEM-O-SOL®** THE MOST ADAPTABLE PLASTIC

For more information, turn to Reader Service card, circle No. 497

ing material for condensers, cables and other electrical parts. It is also recommended for use as a lubricant, mold release agent, paint additive and as a coating for paper.

The wax, called No. 160, is available from Frank B. Ross Co., Inc., 6-10 Ash St., Jersey City 4, N. J. It sells for 53¢ per lb in lots of 2000 lb or more. The wax is soluble in hot solvents and insoluble in water.

KEY NO. 203

PROPERTIES OF NO. 160 WAX

Specific Gravity	1.02
Melting Point, F	313
Flash Point, F	600
Acid Value	5-10
Dielectric Constant	3.0
Dissipation Factor	0.00977

Rust Remover

Development of a non-acid, non-inflammable rust remover has been announced by Turco Products, Inc., 24600 S. Main St., Wilmington, Calif.

The product is said to remove heavy rust and stubborn paint deposits such as red oxide primer, baked lacquer, acidproof paint and asphalt finishes by means of a simple, one-tank operation followed by a pressure rinse. The rust remover contains no cyanide compounds and emits no corrosive fumes.

The rust remover can be used in a soak or electrolytic tank, and requires only a mild steel tank of welded construction with stainless steel heating coils.

Turco says treated metals do not have to be neutralized.

KEY NO. 204

Improved Brass for Durable Radiator Tanks

An improved 70% cartridge brass for automobile radiator tanks is now in production at Chase Brass & Copper Co., Waterbury 20, Conn. Called Hi-Strength, the metal is said to be produced by a unique mill process which, however, has not been disclosed.

The improved brass has higher yield, tensile and fatigue strengths

Steel

For strength
. . . economy
. . . versatility

THE SLOTS IN THIS FORGING SAVED OUR CUSTOMER SEVERAL MINUTES MACHINING TIME

The slots in the part above used to be machined. That took time and tools. It was expensive—*needlessly*.

Now, at Bethlehem's suggestion, the forged part is trimmed along the parting line, then placed in a special fixture in the trimming press where the slots are hot-broached.

The hot-broaching involved a small additional tooling cost. But, now there's no more machining . . . No more wear and tear on machine tools . . . No more waste metal. Take our customer's word for it, his savings more than make up his slightly higher tooling costs.

Our sales engineers will be happy to take a fresh look at your forgings, to talk over your ideas and problems. Perhaps they can help you cut machining costs, too. We suggest that you get in touch with our nearest sales office.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

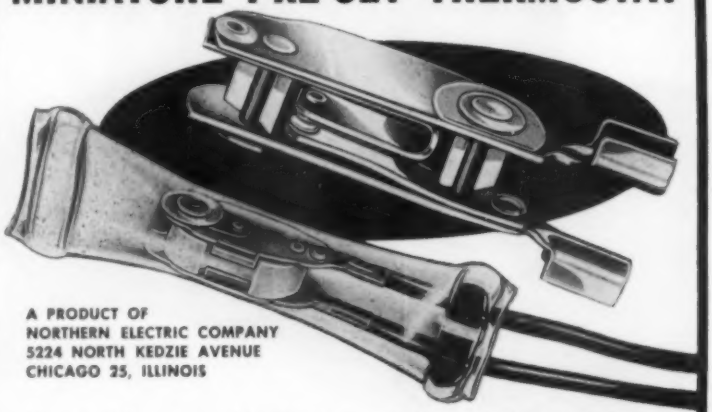
BETHLEHEM STEEL

For more information, turn to Reader Service card, circle No. 413

Chace THERMOSTATIC BIMETAL

Actuates Another Precision Product

Northern Electric
MINIATURE PRE-SET THERMOSTAT



A PRODUCT OF
NORTHERN ELECTRIC COMPANY
5224 NORTH KEDZIE AVENUE
CHICAGO 25, ILLINOIS

Utter simplicity is combined with rugged dependability in Northern Electric's miniature ceramic thermostats. These little super-safety devices provide for protection against excessive temperature for refrigeration and freezer defrost heaters; operation of freezer warning systems; and operation of pilot circuits for other appliances where heat is involved.

Depending on the function, these fine Northern Electric products can be provided with contacts which *open* on temperature rise—or contacts which *close* on temperature rise. Since the brass covers are current carrying parts, Northern Electric supplies the unit in moisture-resistant or hermetically sealed (model X-105, above) insulated enclosures with leads. Capacity is four amperes, non-inductive at 115 volts A.C. The current-carrying actuator in this rugged little control is dependable Chace Thermostatic Bimetal.

Manufacturers large and small have come to recognize — and specify — Chace Thermostatic Bimetal because of its dependability. This dependability is born of more than a third of a century of specializing in the manufacture of one product . . . Chace Thermostatic Bimetal. When you specify Chace, you also receive dependability, uniformity, precision manufacture and economy.

Send Now For Our New "Information Booklet"!

It contains many well illustrated pages of valuable design data and examples of successful applications of bimetal! More than 40 types of Chace Thermostatic Bimetal are available in coils, strips and completely fabricated elements of your design.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

For more information, turn to Reader Service card, circle No. 474

What's new IN MATERIALS

PROPERTIES OF TWO BRASSES COMPARED

Type →	70% Cartridge	Hi-Strength
Ten Str, 1000 psi	46	53
Yld Str, 1000 psi	15	21
Elong (in 2 in.), %	65	52
Fatigue Str (1 x 10^8 cps), 1000 psi	12	16
Rockwell Hardness	F63	F75
Grain Size, mm	0.070	0.025

than conventionally used tank brass (see table). It is also said to have greater resistance to stress corrosion because of an inherently finer grain size.

Price of the improved metal is the same as that of 70% cartridge brass: 48¢ per lb for sheet and wire, and 52¢ for seamless tube.

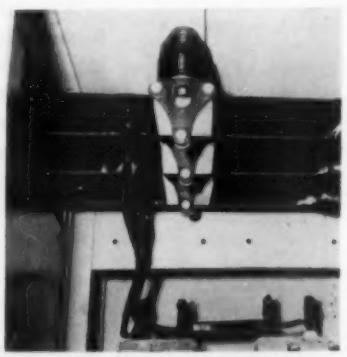
According to Chase, tanks made of the metal have withstood a 50,000-cycle steam-pressure test without failure despite the fact that the metal strip used in the tank was 10% thinner than conventional material.

KEY NO. 205

Vinyl Tape Used at Class A Temperatures

A new pressure-sensitive vinyl tape is designed for continuous use at Class A (220 F) temperatures.

The tape, called Scotch brand No. 66, is available from Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. It is a black,



***Black vinyl tape** is used as an electrical insulation on high temperature busbars.*

7' BOAT (SPORTYAK*, Dayton Bait and Marine Products Co., Dayton, Ohio)—This boat of MARLEX is tough, rigid, unsinkable, lightweight . . . never needs painting. (*A trademark of Woodall Industries, Inc., Detroit 34.)

LAWN MOWER (Jacobsen Mfg. Co., Racine, Wis.)—Grass chute, engine cowling, and wheel hubs of MARLEX are light, tough, and corrosion-free . . . add performance and sales appeal to this popular line of lawn mowers.

POST LANTERN (Western Circle Co., Hazelwood, Mo.)—This "Cape Codder" has established sales appeal. Because of MARLEX . . . it's unaffected by weather, can't rust, keeps color and lustre without painting.

ROPE (Plymouth Cordage, Plymouth, Mass.)—Available in many sizes and colors, rope made of MARLEX is stronger and lighter than manila . . . it floats, does not absorb water or freeze . . . resists most chemicals.

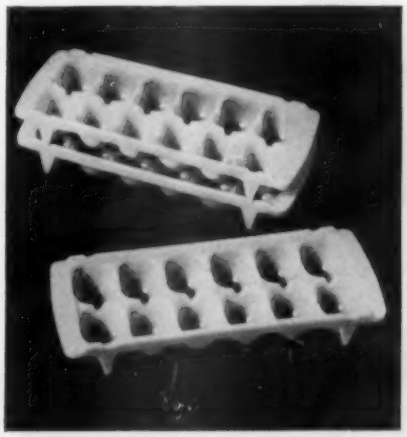
MARLEX* improves product performance . . . increases sales appeal

Shown here are examples of the increasing number of hardware, lawn and garden equipment, sporting goods, and housewares being "quality upgraded" by the use of MARLEX high density polyethylenes and ethylene copolymers. Boats that will never rot . . . rope and bulk bags that are lighter, stronger and moisture-proof . . . outdoor items that cannot corrode—all made of tough, durable, virtually indestructible, economical MARLEX.

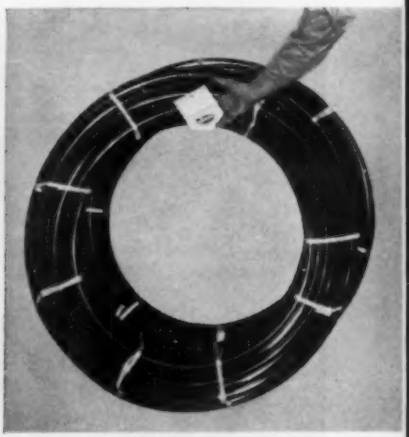
MARLEX high quality plastics are lightweight, tough, rigid or flexible . . . resistant to acids, alkalies, greases, fungi, and corrosion . . . and possess a wide usable temperature range (—180°F to 250°F).

*MARLEX is a trademark for Phillips family of olefin polymers.

NURSERY PRODUCTS BAG (Crystal-X Corp., Lenni Mills, Pa.)—For private-branding your bulk supplies. Bags made of MARLEX are lighter, tougher, moisture-proof and less apt to tear or burst. Easy heat sealing.



POP OUT ICE CUBE TRAY (The Dole Valve Co., Morton Grove, Ill.)—New design and MARLEX cause cubes to "pop out" without "defrosting". Tray is flexible even when ice-cold . . . and tough, sanitary, longer lasting.



MERCHANT PIPE—Available from ½" to 2", this easy-to-install coilable pipe of NSF approved MARLEX has a wide temperature range and extra strength per mil of wall thickness. Quality at moderate cost!

For more information, see your plastic fabricator, or contact us.

PHILLIPS CHEMICAL COMPANY

Bartlesville, Oklahoma

A subsidiary of Phillips Petroleum Company

PHILLIPS 66 MARLEX PLASTICS

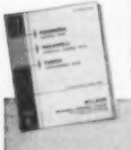
For almost every hardness testing requirement

There's a Wilson "Rockwell" instrument to do the job

Wilson "Rockwell" Hardness Testers can help make your products better, stronger, longer lasting. They give reliable results on the production line, in laboratories, in tool rooms, and in inspection departments. They're as easy to use as a center punch, as durable as a machine tool, as sensitive and accurate as a precision balance. That's why Wilson "Rockwell" is recognized as the world's standard of hardness testing accuracy.

Wilson "Brale" Diamond Penetrators give Perfect Readings

A perfect diamond penetrator is essential to accurate testing. Only flawless diamonds are used with Wilson "Brale" penetrators. Each diamond is cut to an exact shape. Microscopic inspection and a comparator check of each diamond—one by one—assure you of accurate hardness testing every time.



Write for Catalog RT-60. It gives complete details on the full line of Wilson hardness testing equipment.

TWINTESTER
combines functions of "Rockwell" and "Rockwell" Superficial Testers
"ROCKWELL" HARDNESS TESTER
for most hardness testing functions
"ROCKWELL" SUPERFICIAL TESTER
for extremely shallow indentations
TUKON
for precision micro and macro testing
AUTOMATIC—semi-and fully automatic models for automatically classifying tested pieces at rates to 1,000 pieces per hour

WILSON "ROCKWELL" HARDNESS TESTERS

ACCO

Wilson Mechanical Instrument Division
American Chain & Cable Company, Inc.
230-E Park Avenue, New York 17, New York

For more information, turn to Reader Service card, circle No. 472

What's new IN MATERIALS

polyvinyl chloride film coated on one side with a newly developed acrylic polymer adhesive. The adhesive is said to keep its bond when exposed to plasticizing agents, oil and solvents at Class A temperatures.

The new tape conforms to irregular surfaces and contours, has sufficient strength for machine wrapping operations, and provides maximum electrical protection with minimum build-up, according to 3M. The vinyl backing is resistant to sunlight, rain, snow, salt water and alkalis, and is self-extinguishing.

The vinyl tape is expected to be used as an electrical insulation on busbars, switchboards, appliances, TV sets and industrial equipment.

KEY NO. 206

Electroless Solution Plates 24-Karat Gold

A new 24-karat gold plating solution has been introduced by Technic, Inc., P. O. Box 965, Providence, R. I. The solution is said to offer a fast, economical means of depositing thin plates of 24-karat gold directly on copper, brass, nickel, iron, lead and solder without the use of electricity. Deposits as thick as 70 millionths of an inch are possible over solder.

The solution sells for $42 per troy oz in quantities of 100 or more ounces.

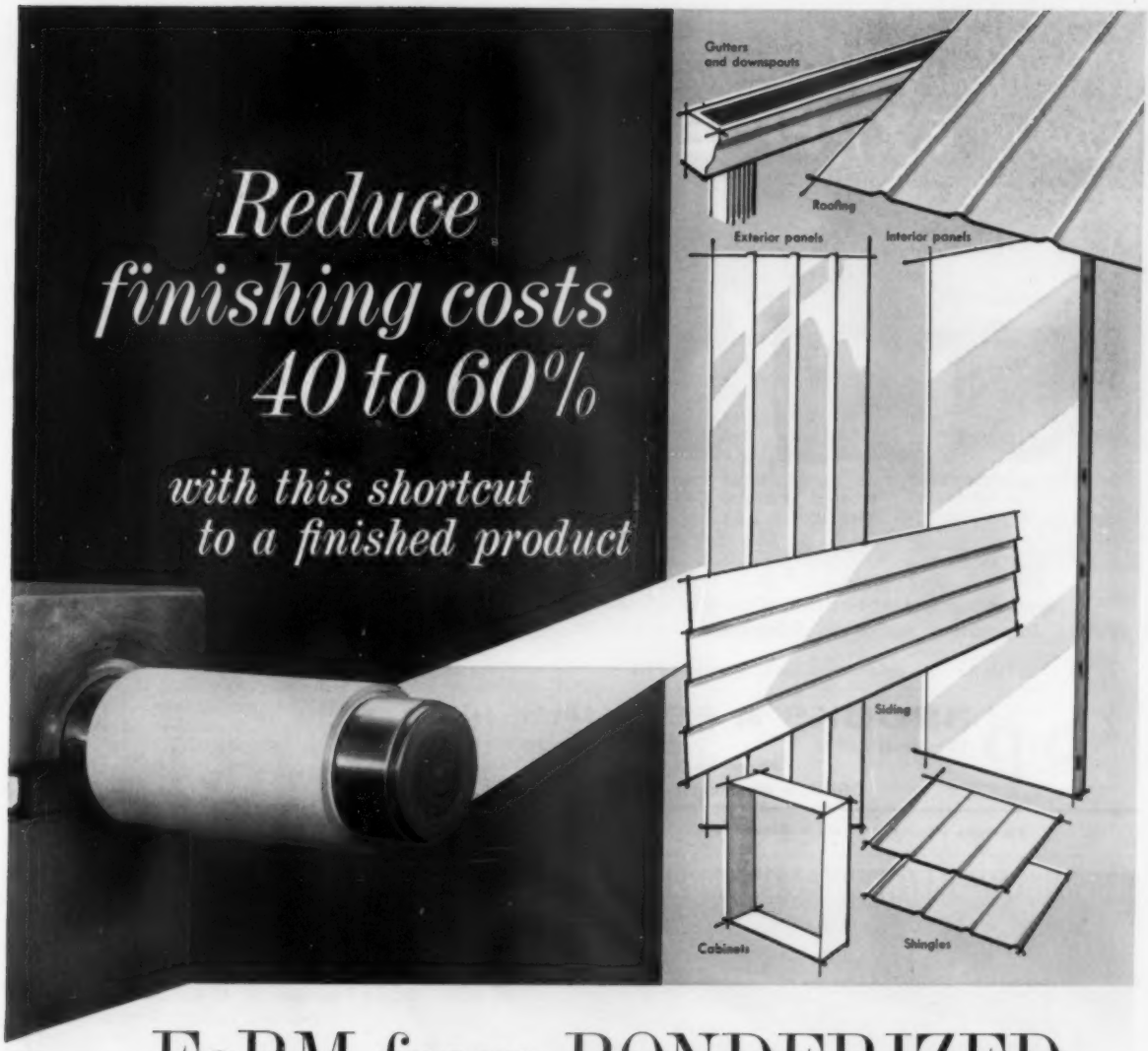
KEY NO. 207

Other News . . .

Metals

▸ Aluminum-silicon-copper solid round and hexagon extrusions for high production screw machine work are now available from Ampco Metal, Inc., 1745 S. 38th St., Milwaukee 1, Wis. The alloy, called Ampcoloy 405, is recommended for use in valve stems, valve seats, gears, marine hardware, pole line hardware, bushings, bearings and cams. KEY NO. 208

▸ An improved nickel-chromium-iron-aluminum resistance wire for precision electrical resistors has been introduced by Driver-Harris Co., Harrison 3, N. J. The wire, designated Karma, has a mean temperature coefficient of resistance of ±5



FoRM from BONDERIZED painted coil stock

Actual field experience and careful cost projections by manufacturers indicate that finishing costs can be cut 40 to 60% by using pre-painted coil stock. This is true for products formed from steel, aluminum or galvanized, using baked-on, high quality paints over Bonderite.

These spectacular savings result from decreased paint consumption and application costs per thousand square feet of surface.

Manufacturers of many types of products are taking advantage of these savings by using Bonderized, painted coil stock for their production now. Coil stock may be treated and painted in the plant, or purchased already Bonderized and painted, ready for forming and fabrication.

The Parker technical representative near you has full information on this revolutionary new way to reduce finishing costs. Or write to Parker, Detroit.

PROTECTED BY Bonderite PARKER RUST PROOF CO. QUALITY CORROSION RESISTANT

Parker Rust Proof Company
2173 E. MILWAUKEE, DETROIT 11, MICHIGAN

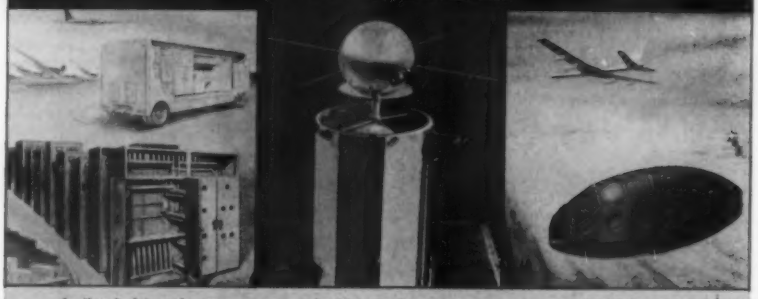
BONDERITE corrosion resistant paint base • BONDERITE and BONDERLUBE aids in cold forming of metals • PARCO COMPOUND rust resistant • PARCO LUBRITE—wear resistant for friction surfaces • TROPICAL—heavy duty maintenance paints since 1883

Since 1914—Leader in the field

*Bonderite, Bonderized, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.

For more information, turn to Reader Service card, circle No. 488

Nowhere else can you buy more **EXPERIENCE...**



. . . in the design and manufacture of lightweight missile support cabinets and consoles.

. . . in high precision manufacture of satellite structural assemblies.

. . . in the design and manufacture of lightweight radar reflectors, plotting board systems and related equipment.

. . . in the design and production of all types of lightweight assemblies of:
Magnesium, Aluminum, Titanium, Zirconium, Beryllium.

Write for more information about Brooks & Perkins' experience

b+p 61-7-1R2

BROOKS & PERKINS, INC.
1916 West Fort St. Detroit 16, Michigan
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Offices in Washington and New York

For more information, turn to Reader Service card, circle No. 390

ON THE JOB EVERYWHERE IN INDUSTRY . . .

BUSADA BUTYRATE TUBING

TRANSPARENT — NON-METALLIC

Consistently high quality . . . Clear . . . durable . . . economical. ¾" to 8½" O.D. 6 ft. and 20 ft. lengths, ¼" thickness.

BUSADA BUTYRATE PIPE AND FITTINGS
First choice of many of the nation's leading firms because it's easier to install, easier to inspect, won't corrode . . . speeds liquid flow.

BEFORE YOU BUY GET BUSADA'S QUOTATION

Busada **Manufacturing Corporation**

32-19 Downing St., Flushing 54, New York, N. Y., LEnox 9-3431

For more information, turn to Reader Service card, circle No. 362

What's new IN MATERIALS

ppm per °C, compared to the previous standard of ±10 ppm per °C. (For more information on resistor alloys, see M/DE, Aug '60, p 121). KEY NO. 209

▸ High purity tellurium metal (99.9999% pure) is now available from Kawecki Chemical Co., Boyertown, Pa. The metal is said to have low oxygen content. KEY NO. 210

Plastics

▸ TFE sheets up to 8 in. thick and 25 in. square are now available from Polymer Corp., 2120 Fairmont Ave., Reading, Pa. The largest sheets previously supplied by the company measured 2 in. thick and 12 in. square. KEY NO. 211

▸ Parts and standard shapes molded of diallyl phthalate compounds are being marketed by Mesa Plastics Co., 12270 Nebraska Ave., Los Angeles 22, Calif. The shapes include panels, slugs, rods, bars, disks and cylinders in various dimensions. KEY NO. 212

▸ A low viscosity, modified epoxy resin now available from Ciba Products Corp., Fair Lawn, N. J. is recommended for use in adhesives, solventless coatings, electrical encapsulating compounds, and laminating and tooling compounds. KEY NO. 213

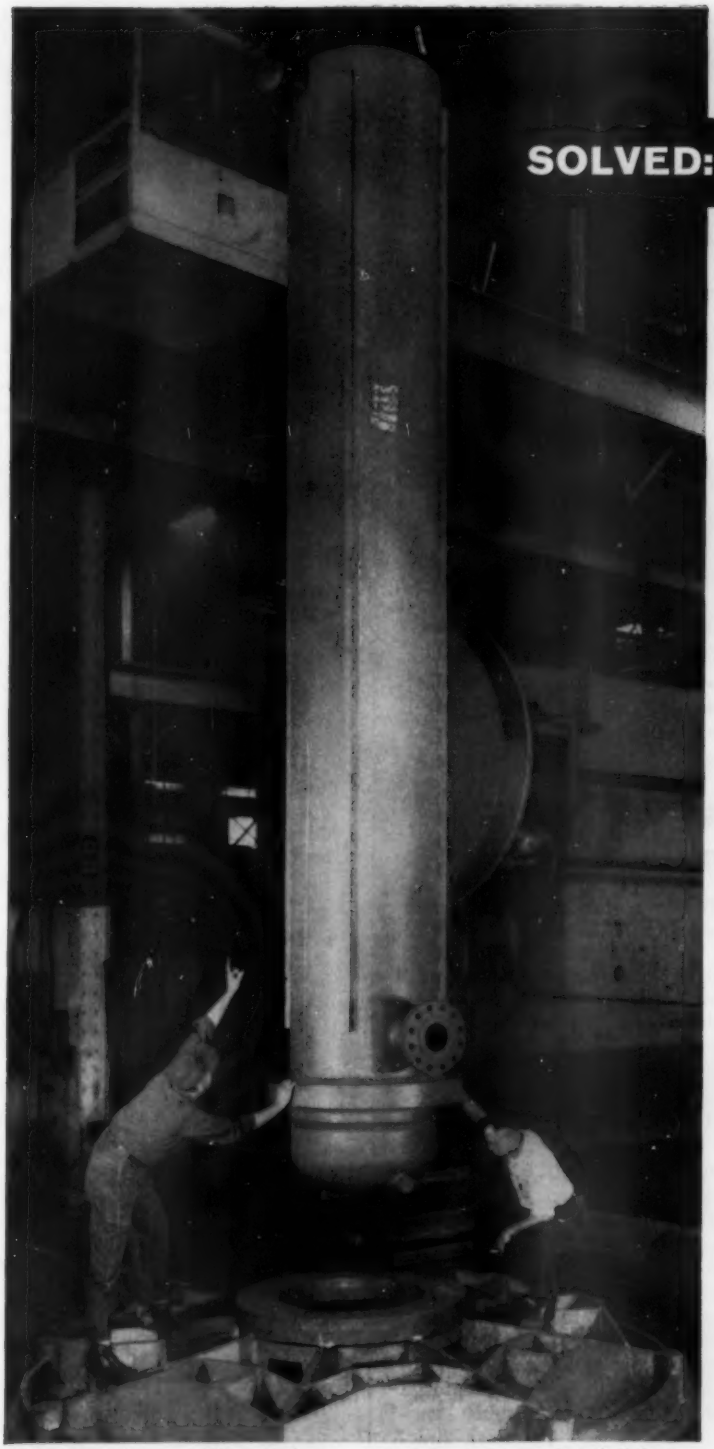
▸ A low shrinkage TFE tape has been introduced by Dixon Corp., Bristol, R. I. for use on electrical wires and cables. According to the producer, the tape does not shrink more than 2% in any dimension when heated 15 min at 730 F. KEY NO. 214

▸ A fiberglass-reinforced polyester molding compound meets Underwriter Laboratory approval for flame retardancy. Called Grade 1506, the compound has high impact strength and good moldability in deep draw parts. It is available from Glastic Corp., 4321 Glenridge Rd., Cleveland 21. KEY NO. 215

▸ A medium-impact cellulose-reinforced phenolic molding compound can easily be compression, transfer and plunger molded. Called RX 522, the compound is available from Rogers Corp., Rogers, Conn. Molded parts have a tensile strength of 8000 psi and a dielectric strength of 300 v per mil. KEY NO. 216

Rubber

▸ A general purpose rubber masterbatch is especially suited for shoe soling and other light colored compounds that require good abrasion



Blaw-Knox workmen assembling one of two constant pressure type accumulators built for two of America's largest steel mills. Sandusky supplied the straight cylindrical sections for both.

SOLVED: by Sandusky Centrifugal Casting

Blaw-Knox chooses 10-ton

SANDUSKY CASTING

for giant slabbing mill

When an 18½-foot cylinder was needed for a new giant Universal slabbing mill built by Blaw-Knox Company's East Chicago (Indiana) Works for a well known steel mill, they found that the most practical and economical way to meet all requirements was with a Sandusky Centrifugal Casting.

This 10-ton carbon steel cylinder, 32" O.D. with a 3½" wall, functions as an accumulator in the mill's hydraulic roll balancing system. Essentially a pressure vessel, it simultaneously supports the ram and ballast weighing 226 tons—the weight required to develop constant operating pressure of 1000 p.s.i.

"Only a dimensionally stable, one-piece cylinder could perform satisfactorily in this service," a Blaw-Knox official asserted. *"Distortion could lead to binding, loss of pressure and costly downtime. Sandusky's ability to produce this heavy walled cylinder in one 18½ foot length met all our requirements of cost, stability, and strength."*

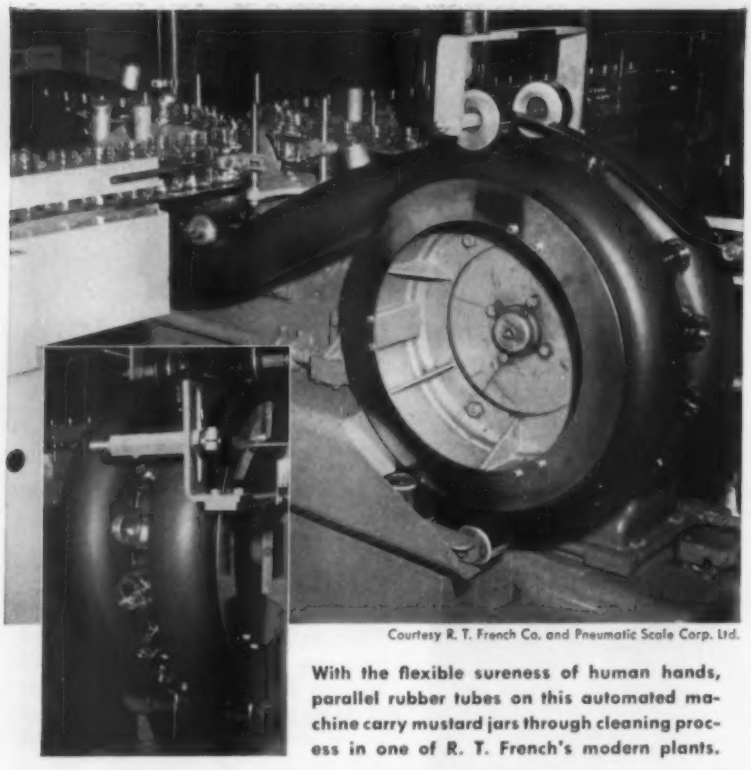
Sandusky cylinders up to 33 feet long —from 7" to 54" O.D.— and in a wide range of ferrous and non-ferrous alloys —may well be the answer to *your cylindrical problems,* too.

Write to us at Sandusky, Ohio. Ask for latest Bulletin #200.

SANDUSKY CENTRIFUGAL CASTINGS
FOUNDRY & MACHINE CO.

SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

For more information, turn to Reader Service card, circle No. 387



Courtesy R. T. French Co. and Pneumatic Scale Corp. Ltd.

With the flexible sureness of human hands, parallel rubber tubes on this automated machine carry mustard jars through cleaning process in one of R. T. French's modern plants.

Pneumatic Rubber Tubes Solve Delicate Handling Problem

Guided by two large pulleys a pair of lightly inflated rubber tubes pick up glass jars from a flat conveyor at the rate of 240 per minute. With a cushion grip that conforms to these irregularly shaped containers the rubber tubes invert the jars and, without ever dropping one, carry them over jets of 60-psi air for scrupulous cleaning.

The success of this unique device depends on ability of the tubes to hold each jar with uniform, safe tension. To do this, the rubber tubes must retain their given size, shape and resilience while constantly stretching and flexing. Superior impermeability is also essential to prevent any dissipation of air even after long periods of use. Furthermore, the tubes must not kink or collapse when taking relatively sharp turns, especially with the thin tube wall and large cross section.

To save the customer extra equipment costs, the "stretch" of the compound was prefigured so that the manufacturing size would inflate to the proper working size without adjustments.

These exacting specifications require a precise blend of synthetics, processed and cured with the expert techniques of rubber specialists to assure a practical, functional rubber compound of exceptionally long working life.

This is another example of the complete engineering, laboratory and manufacturing service given to rubber parts produced by Continental. Next time your product calls for rubber parts, consult Continental—use this specialized help to save both tooling and material costs and still get rubber components that are practical, functional and dependable.

Another achievement in **RUBBER**
engineered by **CONTINENTAL**

CONTINENTAL RUBBER WORKS • 1985 LIBERTY ST. • ERIE 6 • PENNSYLVANIA

For more information, turn to Reader Service card, circle No. 516

What's new IN MATERIALS

resistance. The rubber, called Plioflex RMB 224, is marketed by Goodyear Tire & Rubber Co., Chemical Div., Akron 16, Ohio.

KEY NO. 217

▸ A bitumen-modified synthetic rubber-base calking compound vulcanizes in place to form an elastic, soft rubber-like seal that contracts and expands over a wide temperature range. The compound is supplied as a liquid called UT-60 and as a paste called UT-60F. It is availaible from Dittbrenner Associates, Inc., 18 Oneida Ave., Rockaway, N. J.

KEY NO. 218

Other nonmetallics

▸ Polyethylene-laminated burlap tubing for packaging applications is offered by Burlap Tubing Mfrs. Inc., 2719 N. Edgemont St., Philadelphia 34. KEY NO. 219

▸ A gas-tight, high purity zirconium oxide ceramic has been introduced by Zirconium Corp. of America, Solon, Ohio. It is recommended for use in electronic and nuclear applications. The ceramic is supplied in both commercial and nuclear grades.

KEY NO. 220

Finishes

▸ Two new water-base coatings for ferrous and nonferrous metal parts have been introduced by Bee Chemical Co., 2700 E. 170th St., Lansing, Ill. Lacqua M-802 is designed for forced air drying systems, and Lacqua M-804 for baking systems.

KEY NO. 221

▸ A one-step metal cleaner and conditioner produces a slightly porous surface on metal parts, providing a firm base for paint. The cleaner, designated W.O. No. 1, is available from Turco Products, Inc., 24600 S. Main St., Wilmington, Calif.

KEY NO. 222

Adhesives

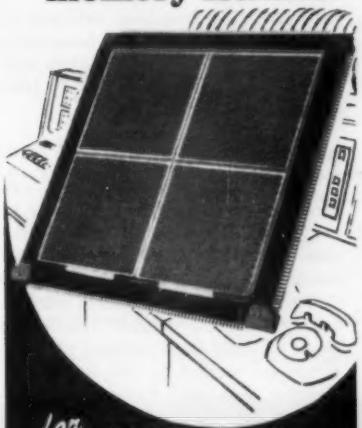
▸ A new contact adhesive, called Clairstick can be used to bond decorative laminates to wood, paper and metals. It is available from St. Clair Rubber Co., 107 Clifford St., Detroit. The adhesive has a coverage of 300 sq ft per gal. KEY NO. 223

▸ A fire resistant adhesive for bonding treated, fire resistant woods has been introduced by Allen Plastics Corp., 1015 E. 173rd St., New York 60. According to the producer, wood bonded with the adhesive can be charred to the point of disintegration without breaking the adhesive bond. KEY NO. 224

example...

FIBERITE

at work in computer memory frames



for IBM Corporation (Poughkeepsie)

Memory-core frames are a vital part of IBM's fabulous computers.

These frames hold and protect the tiny "memory units" which store information for processing.

IBM Poughkeepsie, working with Fiberite Corporation, specified a reinforced plastic frame material with these characteristics:

- The ultimate in dimensional stability under widely varying atmospheric conditions
- High impact and flexural strength
- Minimum shrinkage values
- High dielectric strength
- High heat resistance
- Good molding characteristics
- Automatically preformable

With Fiberite compound F.M. 4005, the exact formulation was achieved through the intense cooperation of Fiberite research engineers and their counterparts at IBM. Results have been called "outstanding."

Your firm, too, can benefit from Fiberite's experience, skill and imagination. Special applications to fit special problems are Fiberite's stock-in-trade.

Why not get complete information on how Fiberite can work for you. Write today for details, and ask also for your free catalog. Today is not too soon!

FIBERITE

THE FIBERITE CORPORATION

Dept. ME 5
514 W. 4th Street
Winona, Minnesota

MOLDING COMPOUNDS

SALES OFFICES IN PRINCIPAL CITIES

For more information, circle No. 437

(cont'd from p 130)

fluoric acid or mixtures of hydrofluoric acid with oxidizing acids. The bath temperature seldom exceeds 130 F although the reaction exotherm is very high and extensive refrigeration is necessary. Insofar as chemical resistance is concerned, the choice of a polymer for titanium maskants is considerably wider than for either steel or aluminum maskants. Vinyl polymers, as well as other materials, will perform well. In practice, however, serious consideration has to be given to titanium's peculiar surface condition which leads to notoriously inconsistent adhesion of maskant materials. Elastomeric maskants used for aluminum have been used on titanium with a good measure of success but with only fair consistency.

Chemical milling of magnesium is also done in acidic baths at temperatures below 100 F. Almost any of the polymers listed in Table 1 would make a satisfactory maskant material. The predominant practice is to use aluminum maskants. Their performance is generally good.

New Heat Treatment Strengthens Inconel W

by Louis A. Weisenberg

Flight Propulsion Div.,
General Electric Co.

Mechanical strength of Inconel W (AMS 5541) has been increased for the temperature range of 750 to 1200 F by changing the heat treatment and aging temperature.

The method was developed by the Large Jet Engine Dept., Flight Propulsion Div., General Electric Co., to adapt the comparatively inexpensive alloy for use in jet thrust reverser doors which operate at about 900 F. This range is too high for high alloy steels and too low to warrant the use of expensive superalloys. (Solutions to other materials problems in thrust reverser design were discussed in M/DE, Nov '60, p 162; Dec '60, p 136).

Thrust reverser doors *at the right of General Electric Co.'s CJ805-23 jet engine are made from specially heat treated Inconel W.*

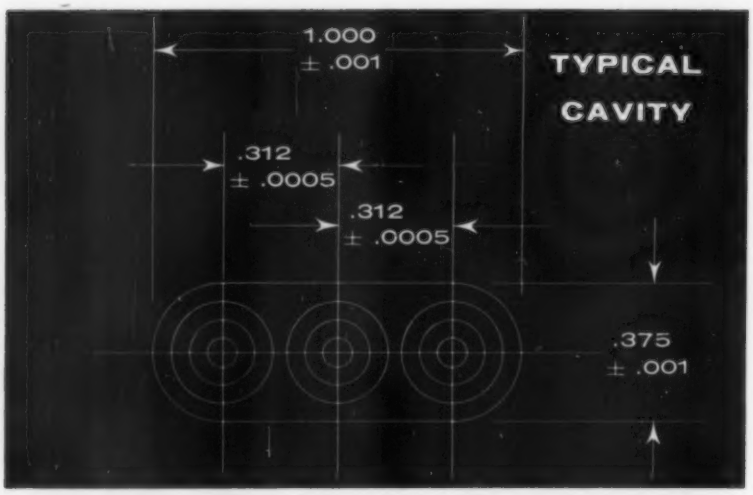
Heat treatments compared

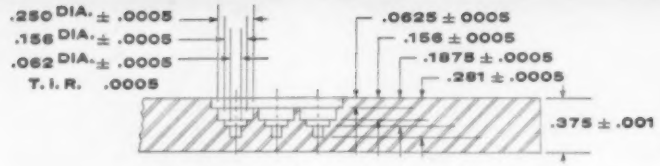
Inconel W is a precipitation hardenable nickel-base alloy, chiefly supplied by International Nickel Co. The new treatment uses an 1800 F mill anneal and solution treatment coupled with a 1325 F aging to raise the tensile and yield strengths of the alloy 20% in the room temperature to 1300 F range. Stress-rupture suffers slightly but only at temperatures above 1200 F.

Conventionally, the alloy is mill annealed at 1975 F, solution treated at 1975 F, and aged at 1450 F. This heat treatment produces good rupture strengths but reduces tensile and yield strengths.

Passes strain-age tests

Weld restraint patch tests show that Inconel W subjected to the new treatment can be welded and heat





UNBELIEVABLY CLOSE TOLERANCES

on graphite jigs and fixtures
. . . but Speer can hold them!

Here are a few examples—

- **Concentricity of drill holes to .0005 T. I. R.**
- **Drilled holes as small as .005 held to ± .0005**
- **Depth of holes held to ± .0005**
- **Oblong or "pork-chop" type cavities—length and width held to ± .001, depth held to ± .0005**

Combine Speer's superb machining skill with the wonders of Speer Graphite itself and you have the perfect solution to many high-temperature problems. Graphite actually gets *stronger* as it gets hotter . . . does not warp . . . will not split or break down under severe thermal shock. It is chemically inert and is not wet by molten metal or glass. Speer Graphite is the ideal material for many high-heat applications, such as transistor jigs, fusing positioners, honeycomb jigs, furnace fixtures, brazing jigs, glass-to-metal seals.

BRING YOUR PROBLEMS TO SPEER! Years of experience in solving tough high-temperature forming and positioning problems with graphite, plus Speer's unusual fabricating skill, provide hundreds of answers for the aircraft, electronics and powdered metals industries.

To obtain full information on Speer Graphite and Speer machining facilities in relation to your specific requirements, send us your detailed blueprints. Your inquiry will receive prompt attention.

SPEER Carbon Co.
CARBON PRODUCTS DIVISION
ST. MARYS, PENNSYLVANIA

Products of the Carbon Products Division include:

Brushes for Motors & Generators • Carbon & Graphite Specialties • Electronic Tube Anodes • Flashlight & Battery Carbons • Plates & Rods • Rocket & Missile Components • Ultra Pure Graphite

For more information, turn to Reader Service card, circle No. 426

treated without resulting in "strainage" cracking.

Hastelloy X has been selected as the best filler wire to use because it has very good welding qualities and yields a joint efficiency 90-95% that of the parent metal.

Sheet-rib construction

The thrust reverser doors are large metal clamshells that close in the exhaust stream to reverse the gas flow. The outer skin of dieformed 0.038-in. Inconel W sheet forms a clean aerodynamic surface during normal flight. Stiffeners made of 0.032-in. Z-sections plus cap strips are welded to this outer skin. Bearing retainers forged from Inconel W are butt welded to the ends of this subassembly along with other components. An inner skin made of three Inconel W panels is then riveted to the frame.

Fabricating the doors from Inconel W has raised no important metallurgical problems, has improved manufacturability, and has somewhat reduced costs. It has also simplified repair welding and maintenance.

New Stress Cracking Test for Plastics

A new testing method for determining the stress cracking resistance of polyolefin plastics measures the stress directly and avoids imposing a strong stress in one direction that might create plastic flow and distort the results as does "bent-strip" testing. Also, polyethylene usually fails by brittle fracture at stresses below its short-time tensile strength.

The new test, jointly developed by F. J. McGarry, Massachusetts Institute of Technology and W. J. Sauber, Dow Chemical Co., applies

COMPARISON OF BIAXIAL AND BENT STRIP TESTS[a]

Melt Index ↓	Biaxial[b]	Bent Strip[c]
5	1000	0.2
12	375	0.3

[a]Type I polyethylene.
[b]Maximum load on each leg (psi).
[c]Time (hr) for 50% of specimens to fail.

ONE KEY TO COST CONTROL IN '61

Savings like these through Metalogics*

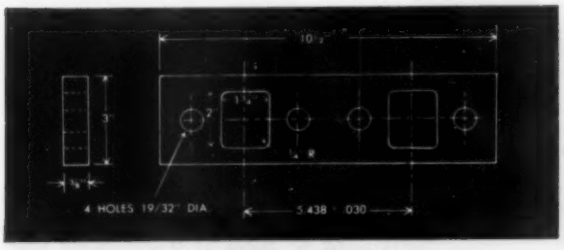
Look at these random examples and see how Ryerson Metalogics sparks real savings for hundreds of companies—in helping to search out new materials, new methods, new machines that will do the job better.

You can count on Ryerson for practical, unbiased recommendations because we offer you:

1. Exceptional knowledge of metals and their characteristics, gained through a century of service to industry as a supplier of metals and machinery for metal fabrication.
2. The nation's largest stocks of steel and aluminum —plus unsurpassed service on industrial plastics.

Your Ryerson representative is "Metalogics-trained" to help you value-analyze selection, fabrication and application problems. Get his constructive ideas soon, and see how he can help you select and apply material from our vast stocks. It's the "Metalogical" thing to do.

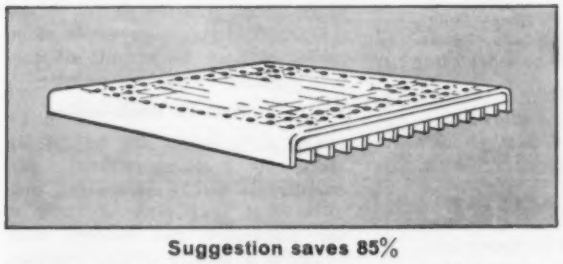
**The Ryerson science of giving optimum value for every purchasing dollar.*



Saved: $100 per thousand

PROBLEM: Muffler manufacturer required accurately finished mounting plates made from ⅜" x 3" bar. Cutting bars to size, burning 1¾" x 2" holes and drilling four 19/32" holes proved time-consuming and expensive.

SOLUTION: Ryerson recommended that they eliminate cutting, burning and drilling operations by stamping the part from Ryerson forming-quality plate. One operation instead of three cut costs $100 per thousand pieces and quickly justified the small initial investment in dies.



Suggestion saves 85%

ASKED FOR: Customer wanted 1" hot rolled plate to cover about 80' of 24" open trench. Plate was to be cut into 24" x 27" segments—each containing 900 ⅜" holes to filter the product.

RECOMMENDED: After studying application and costs, Ryerson recommended a design combining perforated light plate, formed to channel shape, and grating for structural support. Ryerson's experience and imagination saved 85% of the original cost.

Machine cut rings solve problem

PLATES REQUESTED: Ryerson was asked to bid on supplying ¼" Type 410 stainless in 27½" square plates. Material was to be used for orifice plates for 16" burner, subjected to elevated temperatures.

RINGS RECOMMENDED: Going beyond material specs, the Ryerson representative found that the customer intended to cut plate into 27½" diameter length with 13.120" bore—and then mill 12 slots in outer diameter for expansion relief. Knowing the application, Ryerson recommended supplying machine-cut rings in which slots could then be punched rather than milled. Production savings enabled switching to Type 304 at less cost than Type 410 with slots milled.

2 metalworking machines for the price of 1

A fabricator of stainless steel kitchen equipment was recently in the market for a new squaring shear. The one under consideration had a gap-type frame which would enable him to do an important notching operation—necessary for certain sink tops. After careful study, a Ryerson machinery specialist recommended *two* pieces of equipment instead of one at no increase in total cost. The first, an under-driven shear. The second, a universal-type sheet metalworking machine that would do the required notching, plus many other jobs—adding versatility to the entire operation.

Production upped 30%

BEFORE: Job shop was using MT 1015 tubing in the manufacture of this coupling. Machinability was satisfactory, but rising costs of operation led to a search for ways to economize.

AFTER: Careful study by the Ryerson representative brought about a change in material. He recommended using Ledloy® 170 tubing, which increased machining speed to 170 sfm and stepped up production 30%. Ryerson's stocks include the widest range of fast-machining alloys.

STEEL • ALUMINUM • PLASTICS • MACHINERY

RYERSON STEEL®

Joseph T. Ryerson & Son Inc., Member of the JLAM® Steel Family

For more information, turn to Reader Service card, circle No. 396

Wire shaped to fit your design...

• If your design involves wire with special or unusual cross-section, PAGE shaped wire can save material, eliminate machining, forming, forging or similar operations. When you specify PAGE shaped wire, you get these additional advantages:

The shape you need • PAGE can furnish all of the standard shapes, such as squares, ovals, flats and keystones, as well as hundreds of special shapes made to your own drawings and specifications.

Extra strength • PAGE shaped wire is stronger than hot-rolled material. The cold drawing of PAGE shaped wire increases tensile strength, yield point and hardness—improves both wear resistance and machineability.

Many grades of steel • You can specify low carbon, high carbon, alloy or stainless steels, and Armco ingot iron. We'll be glad to recommend the steel best suited to your application.

Accuracy • Both the cross-sections and contours of PAGE shaped wires are extremely accurate, the result of careful cold-drawn or cold-rolled processes in our mill.

Packaged right • PAGE shaped wire is furnished in either standard or special coils of exact weight. Straightened and cut wire is available in either exact or random lengths. It's packaged in bare bundles, wrapped in waterproof paper, burlapped, in cartons, boxes, Leverpaks, or in other ways to meet your requirements.

Write for Book • **DH-1226** *contains data on carbon and alloy steel weights—explains how to calculate areas of common shapes—lists physical properties of steel wire. Write us at Monessen, Pa., for a copy.*

ACCO **PAGE MANUFACTURERS WIRE**

Page Steel and Wire Division • American Chain & Cable Company, Inc.

Monessen, Pa., Atlanta, Chicago, Denver, Detroit, Houston, Los Angeles, New York, Philadelphia, Portland, Ore., San Francisco, Bridgeport, Conn.

PAGE

-the source for answers to wire problems

For more information, turn to Reader Service card, circle No. 433

biaxial stresses in the central area. shaped polypropylene and polyethylene specimens. Equal loads applied to each leg of the equilateral and symmetrical specimen create equal biaxial stresses to maltese-cross-

Four pneumatic cylinders that operate at constant low pressures (0-30 psi) apply a constant load to each leg of the specimen regardless of specimen elongation.

The biaxial test discriminates between the strengths of materials that appear identical or nearly the same when tested by the bent strip method. Results for Type I polyethylene are compared in the accompanying table (p 242).

Testing of Alloy Steel Sling Chains

Methods of testing alloy steel sling chains used for heavy lifting are the subject of a recent report by W. Simon of Westinghouse Electric Corp.'s Materials Engineering Depts.

Mr. Simon says that practically all of the chains purchased by Westinghouse in the last 10 years for use in hazardous lifting operations have been made from heat treated alloy steel. He says AISI 4615, 4620 and 8620 low carbon alloy grades are the steels most commonly used for making chain. But other alloy steels can also be used as long as their carbon contents do not exceed 0.25%. This maximum is placed on carbon content to permit satisfactory welding.

Chain tested to destruction

The accepted method for testing chain for breaking strength and ductility is to: 1) secure the ends of a 36-in. long piece of chain to the stationary and moving cross heads of a tensile testing machine, 2) mark a 10-in. length on the piece of chain at a point approximately equidistant from the heads of the testing machine, and 3) apply a uniform load at a rate of from 2 to 10 ipm.

The minimum elongation requirement for standard heat treated alloy steel chain is 15%. Minimum breaking load varies from 10,500 psi for

SILICOLOGY

Studies in Silicones

HOW THESE TIME-TESTED MATERIALS CAN WORK FOR YOU

For Shear Reliability— Design with Silicone Fluids

Some of the most astonishing things that hydraulic systems are doing today are being done by and because of silicone fluids. In automotive applications, for one, they're the lifeblood of certain long-lasting hydraulic transmissions, power steering, speed-and-temperature-regulated fans. In aviation and other fields, you'll find them in sensitive gyroscopes, damping devices, liquid springs, valve lifters.

MANY USEFUL PROPERTIES

Of course, designing such systems requires knowledge of silicone fluid behavior. Knowledge of viscosity-temperature properties, oxidative and thermal stability, lubricity, thermal expansion, effect on rubber seals of all kinds, compressibility, and apparent viscosity vs. shear rate.

This last is particularly important. And the well-defined shear-viscosity curve of UNION CARBIDE Silicone Fluids, combined with their unique temperature stability (remember that shearing raises fluid temperature), makes them among the most dependable of hydraulic fluids

You may have heard or discovered for yourself that silicone fluids make elastomeric seals shrink, and may even have dismissed them from your consideration, much as you would like to take advantage of their other properties. Then here is news:

EFFECT ON RUBBER SEALS

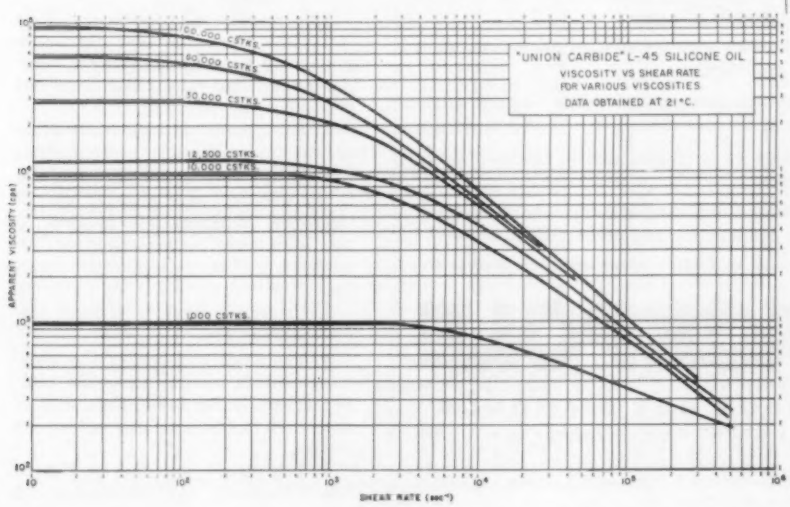
UNION CARBIDE has conducted extensive studies of the effect of silicones on various elastomers, and has shown how this problem can be easily met by the use of proper additives in the fluids. In the accompanying table you can see, for example, how "Plexol" 201 additive (Rohm & Haas) in silicones affects the per cent volume change of Neoprene W rubber. Similar data covers per cent weight change, compression set, hardness, etc. Moreover, these data are available on many other natural and synthetic rubber compounds.

How can you get them? They're available now, along with much other important information including more detailed shear-viscosity curves. Just mail the coupon for our latest "Design File" on UNION CARBIDE Silicone Fluids for Mechanical Applications. It provides in one handy package just about everything you need to know about silicone fluids for your projects.

Effect of Silicone Oil on Neoprene W Rubber

Immersion Fluid	% Volume Change	
	7 days 70°C.	4 days 100°C.
10* L-45	−0.51	−0.15
100* L-45	−0.47	−0.55
1000* L-45	−0.58	−0.69
1000* L-45 + 2.5% "Plexol" 201	4.47	3.75
1000* L-45 + 7.5% "Plexol" 201	17.02	18.60
L-527	8.34	10.66
Water	9.73	15.75

*centistokes



UNION CARBIDE

SILICONES

UNION CARBIDE is a registered trade mark of Union Carbide Corporation.

Silicones Division
Union Carbide Corporation
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Please send me free copy of Design File of Union Carbide Silicone Fluids for Mechanical Applications.

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For more information, turn to Reader Service card, circle No. 424

DON'T OVERLOOK CARBON/GRAPHITE!

No Other Material Can Do ANY of These:

- ★ Withstand immersion in water from 4,000°F without cracking.
- ★ Resist surface atmospheric action while retaining constant and reproducible contact resistance.
- ★ Be readily processed to provide low friction (graphite) or high friction (carbon) or any desired intermediate value.
- ★ Withstand electric arcing in contacts, lightning arresters and similar applications without appreciable dimensional changes.
- ★ Serve as an electrical conductor which is readily machinable and can operate satisfactorily up to 6,000°F.

No Other Material Can Do ALL of These:

- ★ Resist corrosive action of most gases and chemicals.
- ★ Serve as a semi-permanent, readily-formed mold for casting metals or glass.
- ★ Act as a seal ring around a moving shaft to retain liquids and gases.
- ★ Operate as a sliding contact on commutators and slip rings.
- ★ Serve as a bearing material for vacuum applications or as an insert in ordinary bearings.
- ★ Operate as a friction unit in constant-speed clutches.
- ★ Serve as a non-welding contact, either by itself or in combination with other metals.

STACKPOLE CARBON COMPANY, St. Marys, Pa.

STACKPOLE

"EVERYTHING IN CARBON BUT DIAMONDS"

SEAL RINGS • BEARINGS • ROCKET NOZZLES • ELECTROCHEMICAL CELL ANODES • FLUXING TUBES • BRAZING BOATS & TRAYS • CATHODIC PROTECTION ANODES • RISER RODS • VOLTAGE REGULATOR DISCS • ELECTRICAL CONTACTS • HEATING ELEMENTS & ELECTRODES • TUBE ANODES • BRAZING TIPS • RUN-OUT TABLE SLABS • MOTOR & GENERATOR BRUSHES • FRICTION SEGMENTS • PUMP VANES • POROUS CARBON . . . and many more.

For more information, turn to Reader Service card, circle No. 440

¼-in. thick chain to 570,000 psi for 2¼-in. thick chain.

When the test length of chain is pulled to destruction, the break should occur at the end of a link. The fracture should be a ductile shear type. In no case should the test length break in the weld area during the test.

Links tested individually

After tensile and elongation tests have been completed, the chain is proof tested by pulling individual links in the chain on a tensile testing machine. The individual chain links should withstand a load equal to one-fifth of the chain's breaking strength.

The length of chain is then reassembled and pulled as a unit. This assembly should withstand a load equal to the sum of the values obtained for each link.

Plastics Cover for Computer Halves Cost

Use of a glass fiber-reinforced polyester instead of an aluminum casting for the cover of a desk-top computer has halved production costs, simplified assembly and given greater instrument protection.

The new covers are used on the Monroe Calculating Machine Co.'s new Monrobot Mark XI general purpose computer.

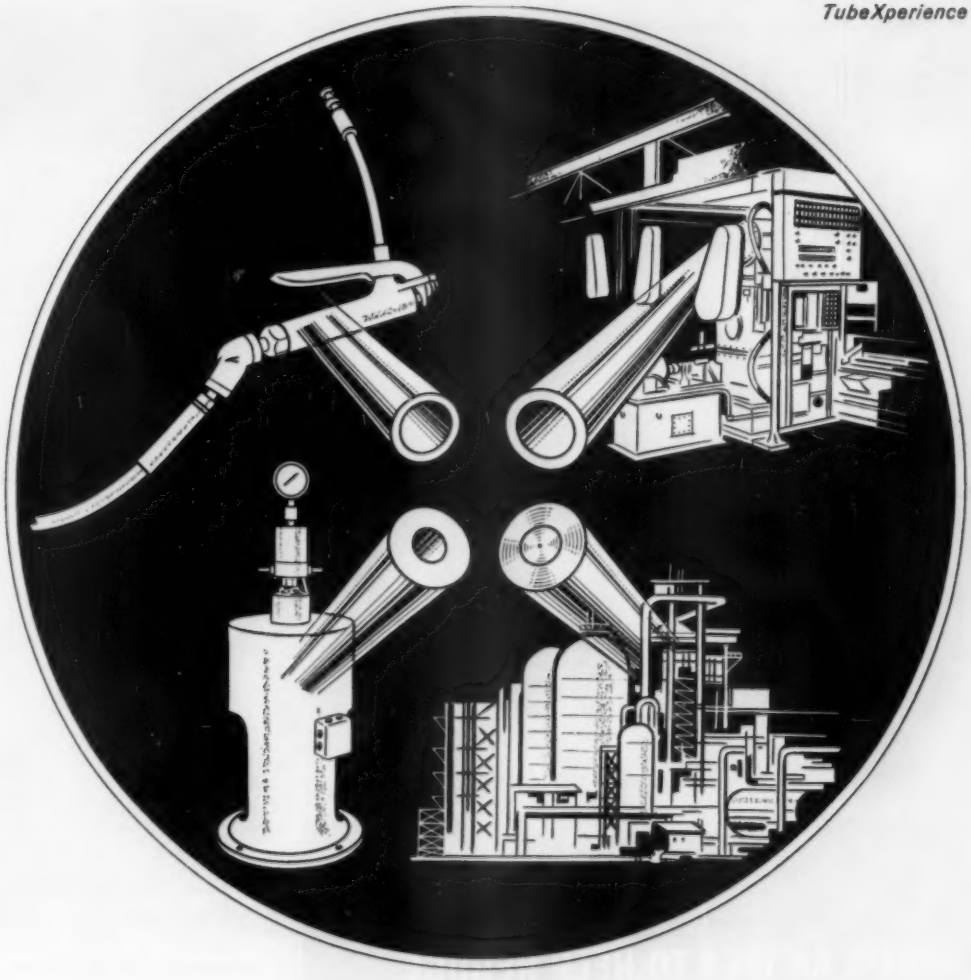
The reinforced plastic not only costs less than the cast aluminum previously used by Monroe on other computers, but also offers several production advantages:

1. The plastic adjusts itself more readily to production irregularities because the covers will bend slightly to fit another part slightly out of tolerance. Whereas 5% to 10% of the aluminum covers required reworking, virtually no plastics covers do.

2. Inspection time is reduced approximately 25%.

3. The amortized cost of the metal match molds used to make the plastics covers is far lower than that of the sand molds used for aluminum covers.

4. The plastic, supplied by Firmaline Products of Crompton &



Superior tubing makes pressures behave

whether 125, 5000, 30,000 or 100,000 psi

Superior small-diameter tubing makes pressures behave whether low, medium, high or super. Superior pressure tubing can be roughly divided into two groups: commercial pressure tubing for use in a range up to 20,000 psi; premium super pressure tubing to handle pressures from 15,000 to 100,000 psi. Both ranges can be handled effectively by a number of different analyses, depending on service requirements. Typical applications for Superior general-purpose pressure tubing include pressure tools, machine tools, heat exchangers and condensers. Superior super-pressure tubing is found in hydrogenation process equipment, high-pressure autoclaves, and pilot plant installations in chemical and oil refining plants.

All Superior pressure tubing offers many advantages. It helps prevent critical failures and downtime. It assures long service life, high fatigue strength, excellent corrosion and chemical resistance. In the range from 15,000 to 100,000 psi, Superior super-pressure tubing is a premium product. It is produced from specially selected raw materials. Inside surfaces are conditioned to remove fissures and other defects. During processing, special degreasing operations are performed, and the inside diameters are conditioned to insure a clear, smooth surface. Two types are available: a single wall mechanical tubing and a double wall, or composite unit, made from two thinner tubes. It is produced in an annealed condition and in ⅛ hard temper, and to mechanical properties specified by the customer. All Superior pressure tubing is 100% hydrostatically tested to recommended working pressures, and rigidly inspected for defects.

We can probably help you with any tubing problem that may confront you . . . in pressure, super-pressure or other applications. Contact us and feel no obligation. Superior Tube Company, 2006 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST

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Buy rings that are formed so close to finished shape and dimensions that very little machining will be needed. The result—less labor, less scrap loss, lower overall cost.

Edgewater rings are forged from solid blocks of steel, and rolled by a powerful ring-rolling mill to required cross-section shapes (see typical profiles above). Close tolerances minimize finishing operations.

Edgewater rolled steel rings are of uniform quality, strong and tough. Diameters: from 5 to 145 inches. Send drawings for recommendations and prices.

INTERESTING description of the ring-rolling process is given in this brochure, **Edgewater Rolled Steel Rings.** We will be glad to send you a copy.

EDGEWATER STEEL COMPANY
P. O. Box 478 Pittsburgh 30, Pa.

For more information, turn to Reader Service card, circle No. 465

Knowles, Midland Park, N.J., is preshaded toward the final dapple finish color. This reduces the number of primer coats required. The plastic base also improves paint bonding and reduces chipping.

Plastic Bobbins for Miniaturized Coils

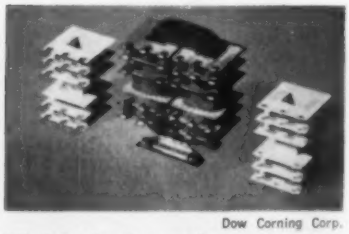
One-piece bobbins and coil forms for miniaturized transformers are being successfully made from a silicone-glass laminate.

The one-piece construction simplifies production, improves rigidity and precision, and contributes to the high temperature resistance required for the small airborne components.

The bobbins are made as hand layups by Silicone Insulation, Inc., New York City for Foster Transformer Co., Cincinnati. The units are said to withstand temperatures over 750 F during tests running over 1000 hr.

Bobbin formed, then laminated

In production, glass cloth impregnated with a silicone resin is formed so that the material flows out from the coil core to form the flanges. This procedure eliminates the usual joined, three-piece construction. The entire layup is then laminated as a single unit in a special mold.



Dow Corning Corp.

***Miniaturized transformer** and its single-piece coil bobbins.*

Embedded Tungsten Strengthens Copper

Embedding fine fibers and filaments of a strong metal, such as tungsten, greatly strengthens copper wires, according to recent research.

Investigators at NASA's Lewis

Tough, durable Mylar® cuts costs... improves product performance

For example, "Mylar"* polyester film's high tensile strength in thin gauges helps make products lighter, less bulky. Yet they last longer. Right now, "Mylar" with its resistance to heat, cold, chemicals and moisture is improving the performance of products as different as lustrous metallic yarns and tough, flexible exchange cable.

Can this unique plastic film and products made with it help you? For more information on "Mylar", write: Du Pont Co., Film Dept., Room #8, Wilmington 98, Del.

1. Pressure-sensitive tape of "Mylar" is thinner, stronger. Resists tearing and corrosive chemicals and moisture.

2. Metallic yarns of "Mylar" stay sparkling through dyeing, washings and wearings, even in sun and salt water.

3. Volatile corrosion-inhibitor packages of "Mylar" fight rust, offer easy identification of parts.

DU PONT

*"Mylar" is Du Pont's registered trademark for its brand of polyester film.

Better Things for Better Living . . . through Chemistry

DU PONT MYLAR® POLYESTER FILM

See Du Pont's complete line of industrial films at the Design Engineering Show, Booth #860

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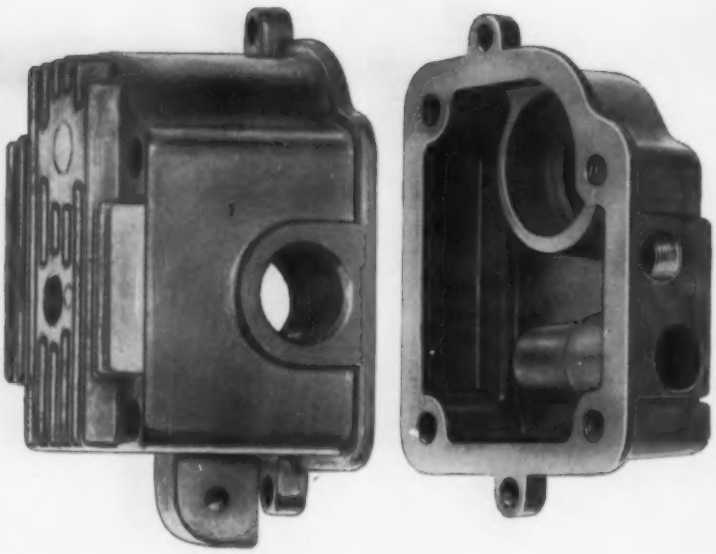
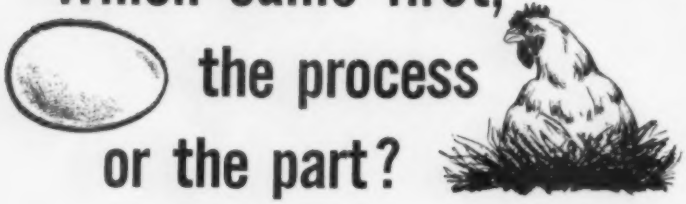


Which came first, the process or the part?



When you see a die casting like this you just about have to ask yourself . . . "Did the production process make the part possible, or did design dictate the process?"

Part-wise this gear box demands precision, strength, heat dissipation, maximum elimination of post-casting machining. It is integral and functional to the power mower for which it was built. Did design dictate die casting?

Process-wise, the shape couldn't have existed with such close tolerances, with such variable shapes without die casting. No known method of parts production could produce the part at such low unit cost and maintain requirements.

Perhaps this is the way to look at it: Good part design and good die casting *combine* for superior results. Since 1919, Twin City Die Castings has aimed its complete plant facilities to achieve this end.

...only DIE CASTING can

✔ cut your costs ✔ offer such flexibility

✔ provide such accuracy

Leading Die Casters in the Upper Midwest

TWIN CITY DIE CASTINGS CO.

3351 TALMAGE AVE. S. E. • MINNEAPOLIS 14, MINN. • PHONE MI 6-7528

RESEARCH PARTICIPANT

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Research Center have found that when the included tungsten filaments run the full length of the specimen, the strength of the composite is proportional to the number of included filaments and to their strength.

For example, copper with a strength of 30,000 psi was strengthened to more than 120,000 psi by replacing 35% of the volume with tungsten fibers that have a strength of 300,000 psi.

Short fibers also work

The same strengths can also be achieved by adding short tungsten fibers to copper. These two developments seem to support the idea that extremely strong metals can be made by additions of the phenomenally strong (2 million psi) whiskers formed when a metal is subjected to electron bombardment.

The high strength of these whiskers and other finely drawn metals is attributed to a reduction in the crystalline imperfections of the metal and to the inherent strengthening caused by reducing a wire's cross-sectional area.

Butyrate Enhances New Vending Machines

Thin, transparent covers of cellulose acetate butyrate plastic fit snugly over facsimile cigarette packages on new vending machines to make the three-dimensional displays attractive, dirtproof and durable.

Behind the covers, which look like the transparent overwrap of real packs, snug-fitting beds of white butyrate hold the facsimiles and their gold-covered frames rigid and

***Display units** for a cigarette vending machine are formed butyrate layers sealed together for attractiveness, durability and cleanliness.*

THIS MAGIC METAL IS ALUMINUM COMBINED WITH STAINLESS STEEL
The unretouched photograph below shows a specimen of Fairmont Stainless Steel Clad Aluminum almost three times actual size. Note the fine bond line of this homogeneous metal—aluminum inseparably bonded to stainless steel.

Now Fairmont creativity combines the advantages of two great metals

FROM POTS AND PANS TO REFRIGERATED TRUCK BODIES

Cooking utensils which combine the excellent heat transfer properties of aluminum with the resistance to food acids of stainless steel. Or refrigerated transport which meets stainless regulations and also makes use of aluminum's light weight for bigger payloads. Or what have you? Fairmont Stainless Clad Aluminum will revolutionize a complete field of metal fabrication. Get in on the ground floor with Fairmont!

THEY SAID IT WASN'T PRACTICAL. But an intensive research program has been concluded, and Fairmont's new Stainless Clad Aluminum is now being rolled on a production basis, via patented methods providing a perfect molecular bond.

By successfully combining the ductility, light weight and high conductivity of aluminum with the strength, corrosion resistance and lustrous beauty of the stainless steel, Fairmont has opened doors wide to a thousand and one product improvements leading to more sales and new products by fabricators of all kinds.

Initially, Fairmont Stainless Clad Aluminum is being produced in flat sheet and flat circles or blanks. Other sheet forms will be made available in the not too distant future. For fabricators who know it pays to plan ahead, NOW is the time to call in a Fairmont representative for detailed facts, figures, application ideas.

FAIRMONT ALUMINUM COMPANY

SUBSIDIARY OF **CERRO CORPORATION**

Sales Offices in Principal Cities

FAIRMONT • WEST VIRGINIA

FAIRMONT 3010 • CABLE ADDRESS: FARMON

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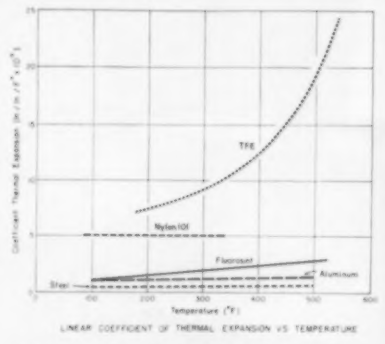
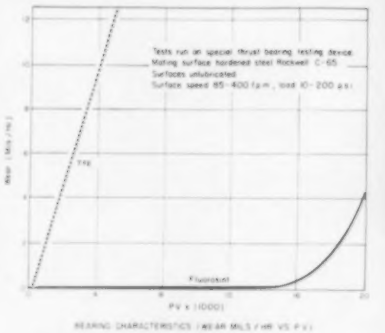
See how FLUOROSINT® parts can outperform regular TFE Fluorocarbons



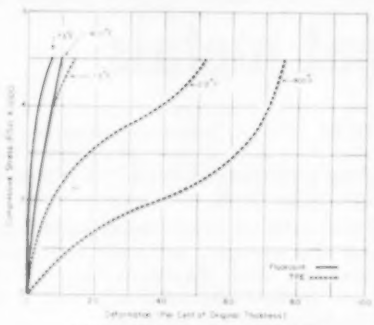
LINEAR COEFFICIENT OF THERMAL EXPANSION VS TEMPERATURE

(1) **in dimensional stability** FLUOROSINT's coefficient of thermal expansion is as low as aluminum.

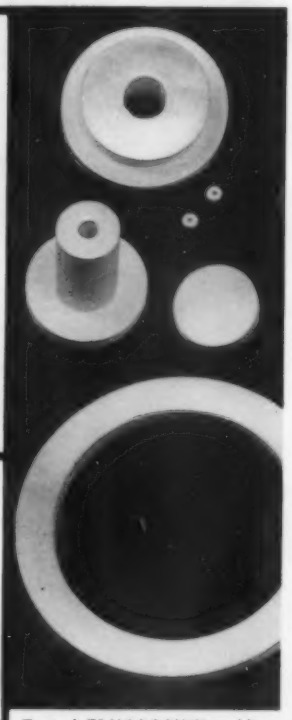

Tests run on special thrust bearing testing device
Mating surface hardened steel Rockwell C-65
Surfaces unlubricated
Surface speed 85-400 f.p.m., load 10-200 psi
TFE
Fluorosint
PV x (1000)

BEARING CHARACTERISTICS (WEAR MILS / HR VS P.V.)

(2) **in bearing characteristics** FLUOROSINT operates at higher loads and speeds, shows far more wear life.



(3) **in resistance to cold flow and creep** FLUOROSINT parts are more rigid, resist deformation at high temperatures.



Typical FLUOROSINT moldings used in mechanical, electrical or chemical equipment.

New FLUOROSINT TFE FLUOROCARBON base composition, composed of TFE fluorocarbon and other specially developed constituents, has been formulated to improve TFE fluorocarbon's mechanical and thermal properties.

For complete technical data on FLUOROSINT's unique properties, write today for new illustrated Bulletin BR-9.

FLUOROSINT stock shapes are also available.

HALEX CORPORATION, Reading, Penna.
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tight. The beds and forms are vacuum formed from extruded butyrate sheet. After the facsimiles and frames are inserted in the cover, the beds are seated behind them and all elements are fused together in a single dustproof unit by ultrasonic sealing before bolting onto a Rowe Mfg. Co., Inc. cigarette machine.

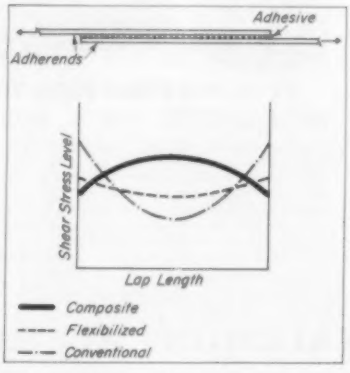
The displays are secured to the front of the vending machine by wing nuts placed on the bed die before forming. The highly extensible butyrate, made by Eastman Chemical Products Inc., forms over, under and around the nuts, and holds them in place.

Rocket Motor Cases Bonded with Adhesives

Sections of high strength cases for solid fuel rocket engines can now be lap joined with special composite adhesives that permit the structure to conform to wall stresses up to and beyond 250,000 psi.

The adhesive combination, designed and being made experimentally by S. J. Dastin and P. Rosenberg, Republic Aviation Corp., Farmingdale, N. Y., differs from conventional compositions because its shear strength decreases from the center to the ends of the lapped joint.

Tests with the new adhesive on a 6-in. lap joint showed that it has a



***Shear stress** distribution along a long lap joint for composite, flexibilized and conventional adhesives.*

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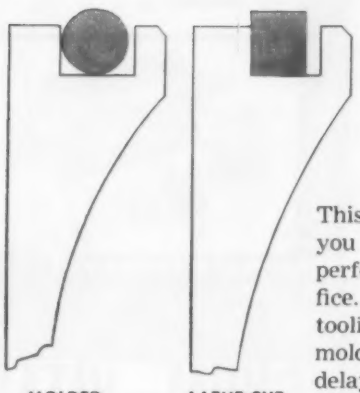
can save you money in *STATIC* or *MOVING* seal applications



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25% higher load carrying capacity than a comparable constant modulus adhesive.

Detailed mathematical analysis of the neglected subject of adhesives behavior in long lapped joints revealed that stress varies considerably through the joint length. Though elongation is negligible in the center of the joint, it is pronounced at the ends. For this reason, less adhesion is desirable at the ends of the joint than in the center. Stress distributions of a conventional adhesive and the new composite system are compared in the accompanying graph.

Joint stands 250,000 psi

In a hydrostatic test, a die steel case 42 in. long and 24 in. in dia, bonded with a conventional adhesive, was sealed to prevent leakage and pressurized with water at 29 psi per sec to failure. The case failed at 1290 psig ± 3%, representing a minimum wall stress of 250,000 psi. The failure occurred within the adhesive as anticipated, since the metal was in its yield range.

Results of this test are believed to indicate that use of a properly designed composite could increase the joint strength to approximately 350,000 psi.

Steel Cutter Wheels Quickly Edge-Hardened

Stainless steel cutting wheels are now being edge hardened in 30 sec by a method developed by Induction Heating Corp., Brooklyn, N. Y.

Rapidly treating the circumference of the wheel at 2000 F and clamping the piece flat during quenching prevents the warpage or distortion that slows conventional production by requiring corrective grinding.

Hardening done in two steps

Because the heat pattern needed to temper wheels is unique, IHC devised an induction coil that would assure even heat distribution across the 15/16-in. width of the hardened perimeter. The heat pattern also had to accommodate the increase in

self-lubricating
BEARINGS — BUSHINGS
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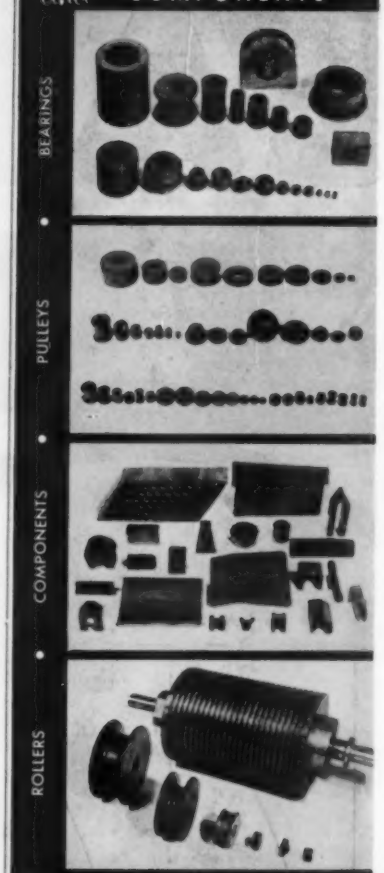

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Lignum-Vitae is ideal for tough "trouble spots"; has unusual homogeneity, great compressive strength (up to 14850 psi). There have been applications where Lignum-Vitae Bearing, water lubricated, lasted ten to thirty times as long as Bronze or Babbitt. Also reduced power consumption 20%.

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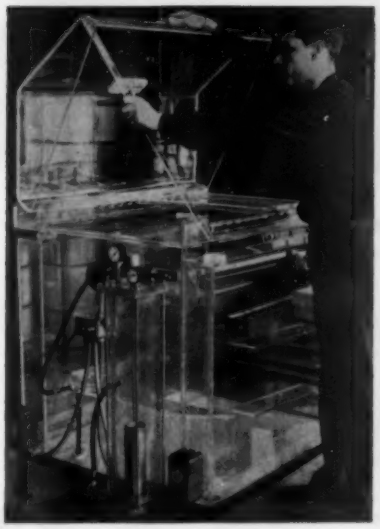

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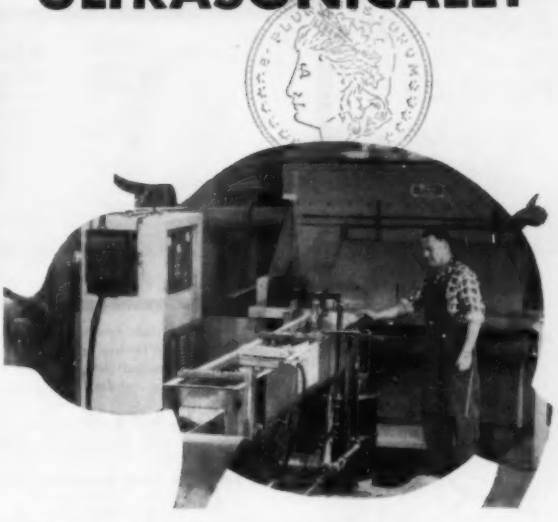

An experimental installation for removal of residual smudge from shot blasted strip by means of ultrasonics. A joint project of Pangborn Corp., Wean Engineering Co., Inc., and Branson Instruments, Inc.

The shotblast method of descaling strip is becoming more and more popular, especially among the lower tonnage producers, converters and fabricators. In this process, hot bands are descaled in a blast cabinet with abrasive shot.-Today ultrasonic cleaning is on the way to replacing flash pickling. This method, which eliminates stream pollution and acid disposal, offers many extras:

• LOW INITIAL INVESTMENT (for tanks due to inexpensive steel construction) • LOW MAINTENANCE COSTS • LOW OPERATING COSTS (in terms of heat and power input) • REDUCED OPERATING TEMPERATURES • LITTLE OR NO CORROSION • NO FUME REMOVAL • NO ACID DISPOSAL • SPACE SAVING • (ultrasonic installations are shorter in length).

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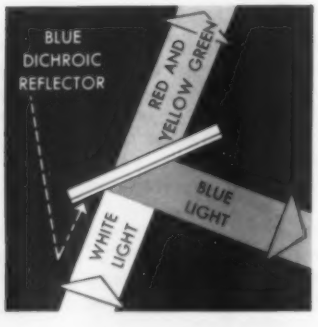

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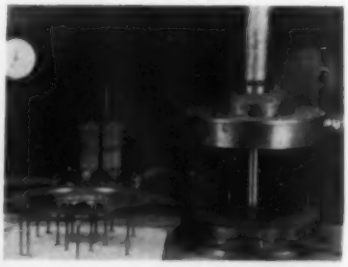
thickness of the disk from rim to center.

The two-position setup used, shown in the accompanying photograph, consists of a heating coil (left) and a quench fixture (right).

The disk is first positioned over the special heating coil which brings it up to hardening temperature.

Thirty seconds after loading, the part is transferred to the quench station. There the quench dies are quickly positioned to hold the disk while air pressure cools it to a level where water quenching can take over. Pressure from the hydraulically actuated upper quench plate presses the blade down onto the quench block and holds it there through the quenching operation. In this way the blade is uniformly hardened over its entire wear surface without warping.



***Heat treating fixture** for hardening the edges of stainless steel cutting wheels. Blades are induction heated in the fixture on the left and tempered in the press at right.*

Airframe Construction Used in Two Bridges

Designers of two new aluminum highway bridges have used aircraft-type, stressed-sheet construction for the first time in bridge design.

The 212-ft long bridges, scheduled for completion this summer near Amityville, N.Y., consist of prefabricated triangular beams lock-bolted together at their edges to form the frame and road base.

Each beam is assembled from aluminum sheet and stiffened internally with aluminum extrusions.

Among the important factors in Shell Chemical's decision to make polystyrene were its extensive background in polymers and its raw material position. Two other Shell thermoplastics followed quickly—polypropylene and polyethylene.

BULLETIN:

On May 3, 1960, a remarkable thermoplastics decision was made by Shell Chemical

Read about this Shell decision. And how you can start benefiting today from a major new source of polystyrene, polypropylene and polyethylene that resulted from it.

ON MAY 3, 1960, Shell Chemical, a company long basic in styrene monomer and SBR rubber, decided to combine the two in full commercial production of Shell high impact polystyrene. Why was this remarkable?

A revealing fact on polystyrene

The condition of the polystyrene market was not attractive. There was oversupply from some of America's finest companies. The field was mature and Shell was starting late.

One revealing fact offset this situation. *Shell, with its excellent background in polymer chemistry—as exemplified by Shell Isoprene Rubber, the industry's first commercially produced synthetic/natural rubber—could make positive contributions to the thermoplastics field in the form of new products.* But Shell would be severely handicapped without a thorough understanding of how the thermoplastics market works and what it wants.

Result? Shell's decision to go full speed ahead with high quality general purpose, medium and high impact Shell polystyrenes, plus a rapidly expanding technical sales force.

80 million pounds of polypropylene

Two other thermoplastic developments followed quickly.

One, Shell's announcement in October, 1960, for an 80 million pounds a year polypropylene plant with customer service and research facilities to be built near Woodbury, N. J. Two, an arrangement by which Shell will resell limited quantities of polypropylene until this plant comes on stream.

Custom-made polyethylene

And this, in turn, led to a third important thermoplastic.

In order to round out a complete line of thermoplastics, Shell Chemical, in January, 1961, made arrangements to supply the industry with the highest quality custom-made polyethylenes.

How to start benefiting

Thus, within 8 months, Shell became an important factor in three plastics: Shell polystyrene, Shell polypropylene and Shell polyethylene.

The next 8 months should be even more important. Shell will be going full speed ahead searching for new polymers you want.

Now is the time to let Shell's technical representative know your needs. Tell him about them on his next visit or write Shell Chemical directly at:

42-76 Main St., Flushing 55, N.Y. FLushing 3-4200; 20575 Center Ridge Rd., Cleveland 16, O. EDison 3-1400; 6054 West Touhy Ave., Chicago 48, Ill. SPring 4-6711; or 10642 Downey Ave., Downey, Calif. SPruce 3-0601.

A Bulletin from

Shell Chemical Company

SHELL

Plastics and Resins Division

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When you are choosing materials for new designs, or when conducting value analysis on existing products, don't compromise on the qualities the parts must have. If you are now using single metals or alloys, chances are you're compromising.

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That's where MULtiLAYER fits into the picture. We will give you a spring steel base material with a layer of copper clad to it and will weld and coin a gold contact ball onto the blade for electrical conductivity. Besides giving you more beneficial engineering properties, MULtiLAYER will probably save you money because you will need less precious metal.

MULtiLAYER, with its hundreds of possible combinations, gives you another modern material. Take advantage of it. WRITE for our general catalog, GP-1B, which describes this material in more detail and illustrates many thought-provoking applications.

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MATERIALS ENGINEERING & DESIGN

After the structure is assembled at the site, standard concrete paving is poured directly on the deck. Corrugations in the road base eliminate the need for pouring forms.

The highly efficient stressed-sheet design permits 1 lb of aluminum to do the work of 4-6 lb of steel in conventional construction, according to Kaiser Aluminum and Chemical Corp.

In addition to minimizing structural dead weight, the use of assembled triangular beams permits the bridge to be designed as a single member, whereas steel stringer bridge construction requires each member to support part of the load individually.

Bearing Simulator Speeds Life Tests

A new ball bearing simulator enables Sperry Gyroscope Co. engineers to evaluate accurately the factors affecting life of ball bearings in only one-tenth the time required for normal run-to-failure tests.

Present models of the simulator duplicate the performance of high speed, high temperature, low lubricant bearings such as those used in

***Ball bearing simulator** cuts testing time by 90%. Effects of lubricants, contaminants and other operating factors are accurately reproduced.*

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miniaturized gyroscopes, motors, or computer memory drums for aerospace vehicles.

The table-top device exactly simulates such factors as operating temperature, atmosphere, ball-to-race contact pressure and surface speed, roll-to-spin ratio, and amount and type of lubricant.

Components for the simulator can be easily manufactured with conventional machine tools. The ball race is flat and can be duplicated as often as necessary. Other parts can be refinished and used repeatedly.

Conductive Adhesives Substitute for Solder

Epoxy-base adhesives loaded with a high percentage of silver flakes are said to be a good way to join electronic components.

The method was developed by R. L. Martin, Kansas City Div. of the Bendix Corp. to overcome the inherent disadvantages of soldering heat-sensitive circuit assemblies, particularly those containing dissimilar metal junctions, etched circuit boards, and semiconductors.

Pass tensile, resistance tests

Nine different adhesive joints were compared with solder joints in electrical resistance and tensile strength. Pairs of ¾-in. dia cylinders were joined in the tests. Steel as well as tinned and bare copper cylinders were used.

The results: the 60-40 solder joints had electrical resistance of 6×10^{-7} ohms and tensile strength greater than 10,000 psi. The most satisfactory adhesive joints, after curing 16 hr at 165 F, had an average electrical resistance of approx 3×10^{-3} ohms and a tensile strength of approx 5500 psi, which are satisfactory for many electronic applications.

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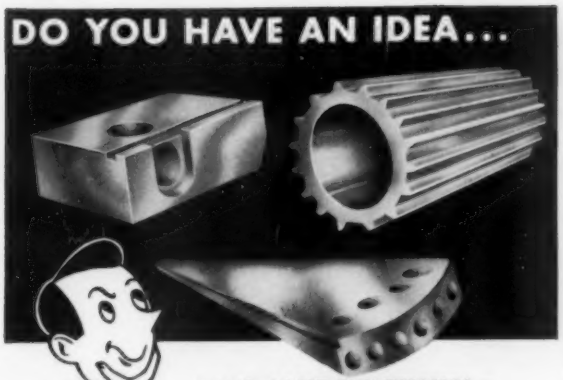

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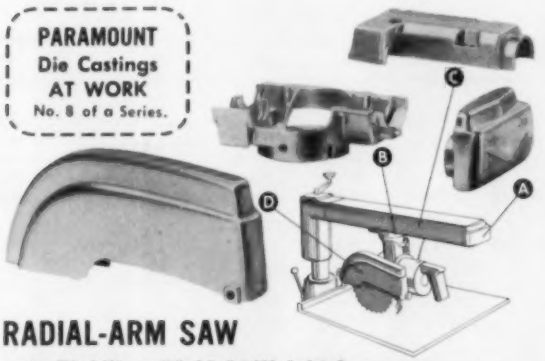
No. 8 of a Series.



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If your product incorporates zinc or aluminum die castings, or you're considering them, investigate Paramount's **complete** services—from drawing board to finished part.

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Three complete plants—two in St. Joseph, Mich., one in Seymour, Ind.

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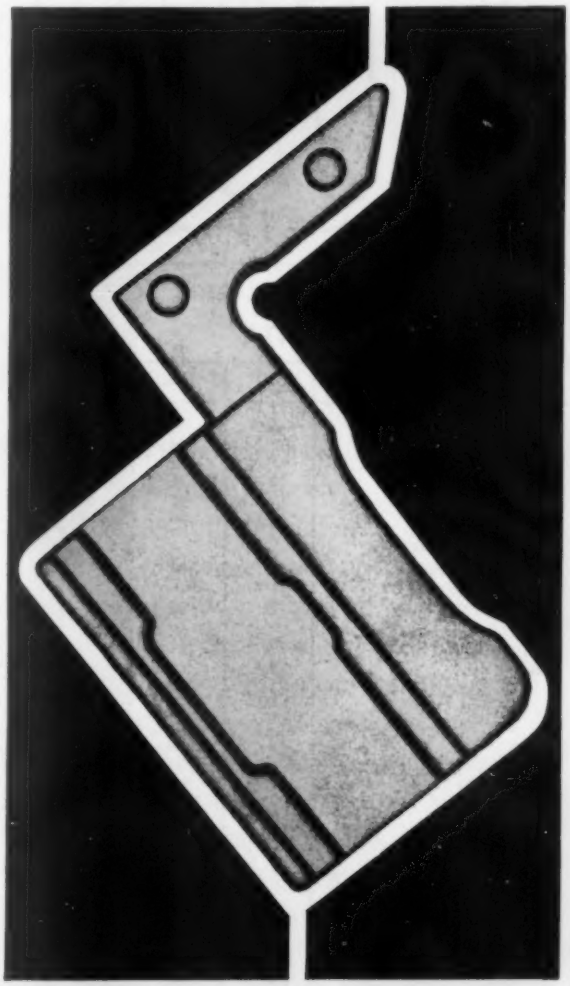

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PROPERTIES	Test Conditions	Units	LUSTRAN I MOLDING 210	LUSTRAN I MOLDING 410	LUSTRAN I MOLDING 610	LUSTRAN I MOLDING 710	LUSTRAN I EXTRUSION* 261	LUSTRAN I EXTRUSION* 461	LUSTRAN I EXTRUSION* 761	LUSTRAN A	ASTM
Tensile											
Stress at Yield	73° F.	psi	9,000	8,000	6,800	6,200	6,800	6,000	5,100	11,800	D638-58T
Stress at Failure	73° F.	psi	6,800	6,200	5,400	5,200	6,200	5,300	4,500	11,800	D638-58T
Elongation at Yield	73° F.	%	3.3	3.0	3.0	3.2	2.2	2.3	2.5	3.0	D638-58T
Elongation at Failure	73° F.	%	45**	55**	55**	70**	25	35	40	3.0	D638-58T
Modulus in Tension	73° F.	psi	420,000	380,000	330,000	300,000	380,000	320,000	280,000	520,000	D638-58T
Flexural											
Maximum Stress at Yield	73° F.	psi	13,700	12,000	10,000	9,200	12,500	10,000	8,500	15,600	D790-59T
Maximum Deflection at Yield	73° F.	inches	0.50	0.47	0.45	0.45	0.3	0.3	0.3	0.32	D790-59T
Modulus in Flexure	73° F.	psi	460,000	400,000	350,000	320,000	400,000	380,000	320,000	—	D790-59T
Impact Strength											
Izod ½" x ½" Bar Mld. (.010" Notch Radius)	73° F.	ft. lbs./in. of notch	1.1	1.8	3.5	4.3	0.9XX	1.8XX	3.6	0.4	D256-56
	0° F.	ft. lbs./in. of notch	0.8	1.2	1.6	2.0	0.6XX	0.9XX	1.8	—	D256-56
	−40° F.	ft. lbs./in. of notch	0.6	0.7	0.9	1.4	0.6XX	0.8XX	1.1	—	D256-56
Izod ⅛" x ½" Bar Mld. (.010" Notch Radius)	73° F.	ft. lbs./in. of notch	1.3—4.0	2.5—5.5	4.0—6.0	6.0—8.5	—	—	—	0.4	D256-56
	0° F.	ft. lbs./in. of notch	0.7—1.2	1.1—1.6	1.4—2.0	2.0—2.6	—	—	—	—	D256-56
	−40° F.	ft. lbs./in. of notch	0.6—0.8	0.7—1.0	0.9—1.2	1.1—1.8	—	—	—	—	D256-56
Hardness											
Rockwell	73° F.		R-110	R-113	R-108	R-100	R-113	R-108	R-102	(M85-M90) R-122	D785-51
Thermal											
Deflection Temp. under Load Unannealed ½" x ½" Bar	264 psi	°F.	185	183	178	177	198+	192+	187+	197	D648-56
Physical											
Specific Gravity (Naturals)		—	1.07	1.06	1.05	1.04	1.07	1.06	1.04	1.08	D792-50

*Data on Extruded Sheet **Monsanto Test +Data on Molded Samples XX½" x 0.115" Bar-Sheet

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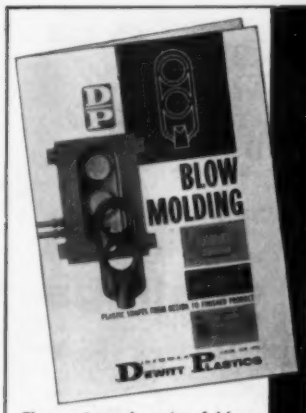

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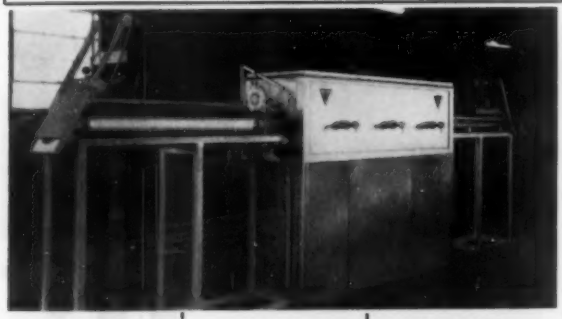

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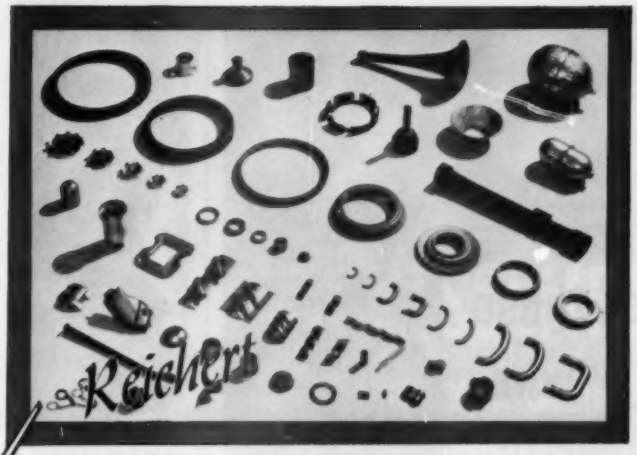

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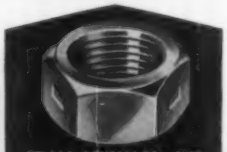

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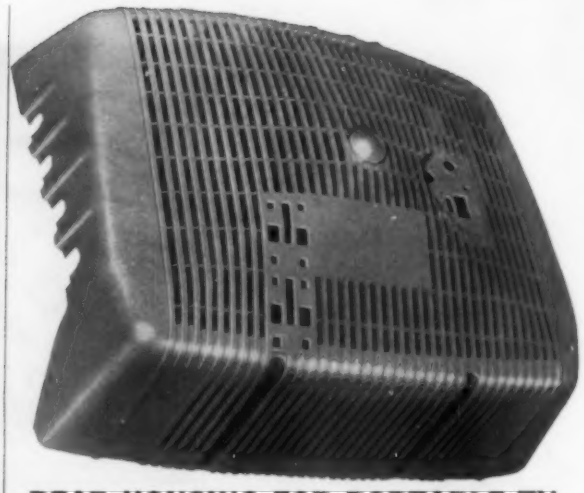

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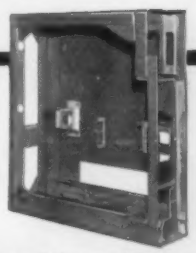

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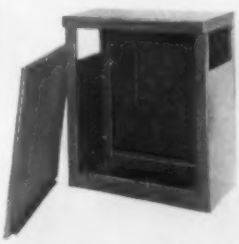

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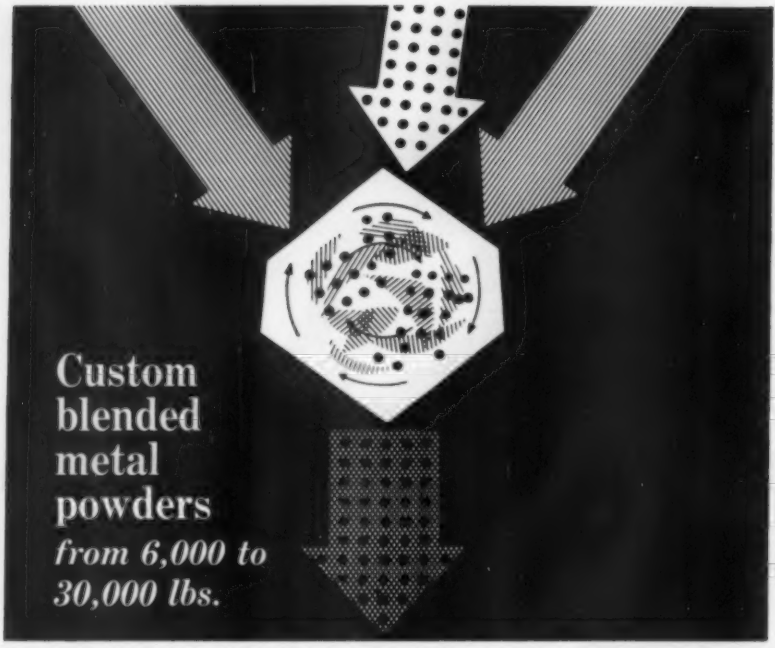

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* *These manufacturers advertised their products in the 1960-61*

MATERIALS SELECTOR REFERENCE DATA ISSUE

For more complete information, and application data on their lines, refer to the index of Advertisers in the Mid-November MATERIALS SELECTOR ISSUE *of* MATERIALS IN DESIGN ENGINEERING.

THE LAST WORD

by **H. R. Clauser**
Editor

Diapers and Metal-Reinforced Cows

■ Despite the many thousands of engineering materials available today, engineers still rely on many less sophisticated materials which were never intended for industrial use.

For example, the list of materials used at Republic Aviation Corp. in the manufacture of the supersonic F-105 fighter-bomber includes such odd items as talcum powder, bicarbonate of soda, castile soap and baby's diapers. The diapers, being lint-free, are excellent for polishing canopies. The talcum and soap serve as lubricants in fabricating rubber and plastic components. And the bicarbonate is used as a cleaning agent in the paint shop.

On the other hand, strange uses also are made of metals and chemicals which are usually thought of only in terms of engineering use. Some months back it was reported in the newspapers that the opposition leader in the Cameroon Republic was allegedly poisoned by his enemies with the metal thallium. Needless to say, the largest single use of this metal is in rat poisons.

And just recently we learned of the use of metals in cattle feed. According to a recently issued patent, feeding metals to cattle improves their digestion. The inventor, B. P. Cardon, who patented the feed for the Erly-Fat Livestock Feed Co., says that essential trace metals in chelated form improve the digestibility of low grade feeds such as cotton gin waste by promoting bacteria development in the first stomach (cows have four, you know). The metals mentioned include iron, copper, manganese, molybdenum and zinc.

Perhaps you are making odd use of materials such as bubble gum, buttons, shoe laces, false teeth, toothpaste, nail polish, etc. or odd use of common engineering materials. If so drop me a line and I will list them periodically in this column.

Monkeys, Secretaries and Engineers

■ In a recent issue of the *Worm Runner's Digest*, the informal journal of the University of Michigan's psychology department, Canadian psychologist Robert Sommer, does some tongue-in-cheek speculating on the importance of secretaries in technical and scientific work. Here are some of his observations and conclusions.

1. A good secretary is worth at least two good scientists or engineers, because it is axiomatic that a lab can produce only as fast as its secretaries can type.

2. The law for output of any technical organization is:

$$\text{Productivity} = \frac{\text{No. of Secretaries} \times \text{Avg Typing Speed}}{\text{No. of Technical Men}}$$

It is easy to see that it follows from this law that when the number of technical personnel becomes zero, productivity becomes infinite.

3. The technical department with one engineer or scientist and four secretaries is in a more favorable position than the one with four scientists and one secretary. Why? In the former case the engineer will have to drive himself harder to produce enough to keep his four secretaries busy in order to avoid criticism from his superiors. In the latter case the engineer will spend most of his day peering over the one secretary's shoulder to be sure she is not showing favoritism to his three colleagues.

4. There is a familiar theory that if a monkey were to punch four keys at random over a long period, he would hit upon $E = mc^2$ in less time than it took Einstein. It follows then that if say four secretaries were to type random letters at top speed, new scientific laws would be produced at a much greater rate than is now being done by our scientists.

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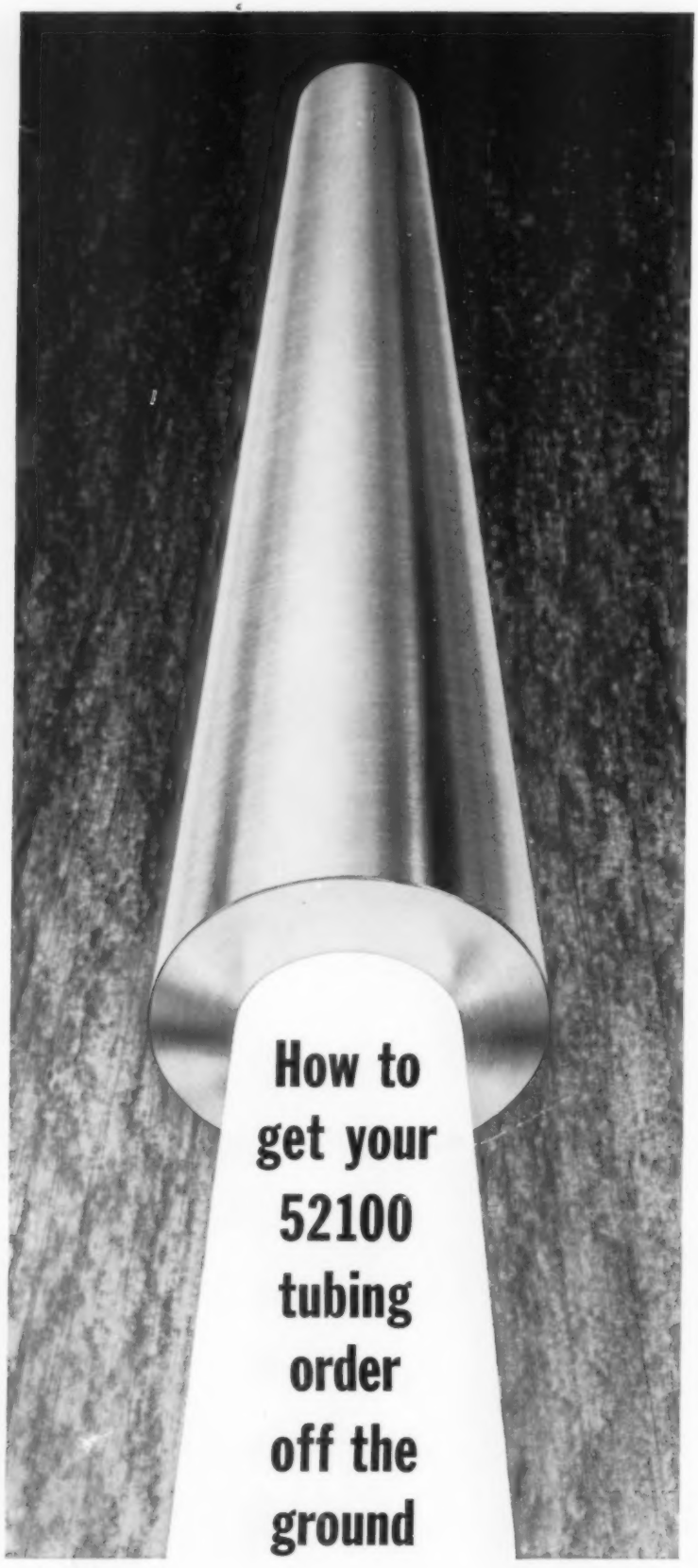

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